2022 Groundwater Monitoring Report
McKenzie Trails Recreation Area
NE and SE Portions of Section 28-038-27 W4M

PRESENTED TO
City of Red Deer

JUNE 16, 2023
ISSUED FOR USE
FILE: 704-SWM.SWOP04071-03.003

Tetra Tech Canada Inc.
Suite 110, 140 Quarry Park Blvd SE
Calgary, AB T2C 3G3 CANADA
Tel 403.203.3355 Fax 403.203.3301

This page intentionally left blank.

EXECUTIVE SUMMARY

The City of Red Deer (The City) retained Tetra Tech Canada Inc. (Tetra Tech) to conduct the 2022 groundwater and vapour monitoring program at the former landfill located beneath the McKenzie Trails Recreation Area (McKenzie Trails), located within the NE and SE Section of 28-038-27 W4M in Red Deer, Alberta, hereafter referred to as the site. The objective of the monitoring program is to identify potential environmental concerns related to former operations at the site.

Tetra Tech's scope of work for the 2022 monitoring and sampling program at the McKenzie Trails site included conducting an annual groundwater monitoring and sampling event, reviewing, and updating previous recommendations for the site, and preparing an annual report. Soil vapour monitoring or sampling was not proposed for 2022.

The groundwater monitoring network at the site consists of six monitoring wells (MW-01 to MW-05 and MW-203). MW-03 (deep) and MW-04 (shallow) are a nested pair located in the northeast section of the site. Most of the wells are screened within the native sand and gravel. MW-05 is screened within the municipal solid waste (MSW) to bedrock. The vapour monitoring network consists of one vapour monitoring well (VW-01) near the southeast corner of the site.

Based upon the results of the groundwater monitoring and sampling conducted in 2022 and previous years, Tetra Tech has developed the following conclusions:

- The groundwater elevations in 2022 indicated that the inferred groundwater flow direction was to the north-northeast, following the flow direction of the Red Deer River. The average horizontal hydraulic gradient at the site in December 2022 was approximately 0.004 m/m, which is consistent with previous findings.
- Routine groundwater chemistry parameters and dissolved metals that exceeded the Tier 1 Guidelines at one or more monitoring wells in 2022 included total dissolved solids, ammonia, and the dissolved metals iron, manganese, and selenium. The measured concentrations of one or more of these parameters suggest leachate has impacted the groundwater quality at MW-03, MW-04, and MW-203, each hydraulically down-gradient of the waste disposal area.
- In 2022, monitoring wells MW-04 and MW-203 contained ammonia that exceeded the guideline value derived in accordance with the Environmental Quality Guidelines for Alberta Surface Waters. The calculated guideline value for MW-04 was 8.50 mg-N/L and for MW-203 was 9.21 mg-N/L (Government of Alberta 2018), while the measured concentrations were 11.0 mg-N/L and 14.1 mg-N/L, respectively. Groundwater near MW-203 and MW-04 is expected to ultimately discharge into the Red Deer River, as the monitoring wells are located approximately 30 m and 90 m from the river, respectively. Based on the measured concentrations and the expected dilution effect when groundwater discharges, the environmental risk is considered low.
- Concentrations of benzene, toluene, ethylbenzene, and xylene (BTEX) and petroleum hydrocarbon (PHC) fractions F1 to F2, were less than the analytical detection limits at most locations in 2022. MW-203 had a detectable concentration of benzene (0.00079 mg/L), marginally greater than the analytical detection limit (0.00050 mg/L). Concentrations of BTEX and PHC fractions F1 and F2 were less than the Tier 1 Guidelines at all locations.
- Concentrations of vinyl chloride were greater than the Tier 1 Guideline in the groundwater samples collected from MW-03, MW-04, and MW-203. Additionally, concentrations of cis-1,2-dichloroethene (cis -1,2-DCE) were detected at MW-03, MW-04, and MW-203. The concentrations of vinyl chloride and cis-1,2-DCE measured are indicators of MSW leachate impacting the groundwater below the site. However, the concentrations of both Volatile Organic Compounds (VOCs) have been consistent since 2019, the concentrations are considered low, and the VOC concentrations are not interpreted to impose a significant risk to the freshwater quality in the nearby Red Deer River.

- During the December 2022 monitoring event and in May 2023, a site walkover was conducted to assess the thin soil cover identified in the earlier work by Tiamat Environmental Consultants Ltd., to evaluate for exposed wastes and/or seepage along the riverbank. No potential exposed waste and/or seepage was identified during the site walkover in December 2022 or May 2023. Future site walkovers should be conducted in the Spring/Summer to ensure the site is not snow covered.

Based upon the results of the groundwater monitoring program in 2022 and previous years, there are residual impacts in the groundwater and buried waste remains beneath the site; therefore, ongoing risk management is required including ongoing monitoring and administrative actions. The following recommendations are made according to these risk management elements:

- Ongoing Monitoring:
  - The groundwater results in 2022 remained consistent with previous results from 2019 and 2021. Consequently, Tetra Tech recommends following the table below that was originally proposed in the 2021 Groundwater and Soil Vapour Monitoring Report (Tetra Tech 2022a) and conducting the next annual groundwater monitoring and sampling event in 2024. The proposed frequency should be re-evaluated at the time of each event based on ongoing results evaluation.
  - It is recommended that the annual site walkover take place during the Spring/Summer to adequately assess the soil cover and riverbank.

Proposed Groundwater Monitoring Program

Activity	2023	2024	2025	2026	2027	2028	2029	2030	2031
Annual Groundwater Monitoring (six wells; MW-01, MW-02, MW--03, MW-04, MW-05, and MW-203)		X			X				X
Annual Groundwater Sampling (three wells; MW-03, MW-04, and MW-203)		X			X				X
Annual Site Walkover in Spring/Summer		X			X				X

- Administrative Actions:
  - Utilize the revised generic mitigative measures (when evaluating applications for development within the setback).
  - Ensure that the site is clearly identified within The City's Land Use Bylaw and appropriate administrative requirements are met for the site in accordance with City policies.

Further to the above recommendations, as noted the site remains an historical landfill. It presently appears to be well maintained and capped. The City should review this status on an ongoing basis to ensure that the cover remains intact and drainage remains positive; repairs or maintenance should be undertaken as required to maintain the site.

TABLE OF CONTENTS

APPENDIX SECTIONS

TABLES

FIGURES

APPENDICES

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of The City of Red Deer and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than The City of Red Deer, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in Appendix A or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

The City of Red Deer (The City) retained Tetra Tech Canada Inc. (Tetra Tech) to conduct the 2022 groundwater monitoring program at the former landfill located beneath the McKenzie Trails Recreation Area (McKenzie Trails), located within the NE and SE Sections of 28-038-27 W4M, hereafter referred to as the site.

Tetra Tech previously undertook groundwater and soil vapour monitoring at the site in 2019 and 2021 based on a broader program for The City's pre-1972 landfill sites. The results of that monitoring program identified indications of leachate impacts related to the former landfill operations at several monitoring wells. Based on these findings, Tetra Tech recommended conducting an additional year of groundwater monitoring to confirm the concentrations of leachate related parameters.

This report presents the results of the 2022 groundwater monitoring and sampling program at the site, which was undertaken based on the document 2022 Work Scope and Cost Estimate – Red Deer Pre-1972 Landfills, submitted to The City on October 21, 2022 (Tetra Tech 2022b).

1.1 2021 Report – Key Findings and Recommendations

The scope of work for the 2021 monitoring program was based on the proposal submitted by Tetra Tech on March 2, 2021, to The City to conduct environmental monitoring services for the pre-1972 landfill sites.

The objectives of the project outlined in the 2021 proposal were to:

- Consult with the regulator on amendments to the program, as required.
- Conduct environmental monitoring and sampling for each of the eight sites, as recommended in the 2019/2020 reports.
- Update the hazard quotients for sites with additional vapour samples in 2021, where applicable.
- Prepare an annual monitoring report for each of the eight sites.

The 2021 groundwater and vapour monitoring report (Tetra Tech 2022a) identified that there was no evidence of significant concerns related to the former landfill operations at McKenzie Trails. However, there was evidence of residual impacts by leachate and the site does contain buried landfill waste; therefore, some risk management measures were recommended to be required. Key findings of the report included the following:

- The groundwater elevations in 2022 could not be contoured as there were no clear elevation differences in the central portion of the site, while elevations at wells away from the centre may have been influenced by water level fluctuations in the nearby Red Deer River and adjacent channel sediments. However, the inferred groundwater flow direction based on historical results was overall northerly, which is consistent with the flow direction in the Red Deer River.
- Routine groundwater chemistry parameters and dissolved metals that exceeded the Tier 1 Guidelines at one or more monitoring wells in 2021 included total dissolved solids (TDS), sodium, ammonia, and the dissolved metals arsenic, iron, manganese, and selenium. The measured concentrations of one or more of these parameters suggested leachate has impacted the groundwater quality at MW-03, MW-04, and MW-203, each hydraulically down-gradient of the waste disposal area.
- Concentrations of dissolved benzene, toluene, ethylbenzene, and xylenes (BTEX) and petroleum hydrocarbon (PHC) fractions F1 to F2, were less than the analytical detection limits at most locations in 2021. MW-203 had a detectable concentration of benzene (0.00058 mg/L), marginally greater than the analytical detection limit (0.00050 mg/L). Concentrations of BTEX and PHC fractions F1 and F2 were less than the Tier 1 Guidelines at all locations.

- Concentrations of vinyl chloride were greater than the Tier 1 Guideline in the groundwater samples collected from MW-03, MW-04, and MW-203. Additionally, concentrations of 1,2-dichloroethene (cis) (cis-1,2-DCE) were detected at MW-03, MW-04, and MW-203. The concentrations of vinyl chloride and cis-1,2-DCE measured are indicators of municipal solid waste (MSW) leachate impacting the groundwater below the site. However, the concentrations of both volatile organic compounds (VOCs) have been consistent since 2019, the concentrations are considered low, and the VOC concentrations are not interpreted to impose a significant risk to the freshwater quality in the nearby Red Deer River.
- In 2021, methane was not detected at vapour well VW-01. The methane concentrations from the groundwater monitoring well headspaces were also measured and were all relatively low ranging from less than the instrument detection limit (5 parts per million [ppm]) at several wells in July and November to 190 ppm at MW-01 and MW-03 in July. For methane, 50,000 ppm, or 5% gas, is equivalent to the lower explosive limit (LEL). Additionally, methane concentrations in the on-site bathrooms were monitored, and the concentrations ranged from 10 ppm in November 2021 to 90 ppm in July 2021. The likelihood of methane accumulating in the outdoor bathrooms is low as they are open to atmospheric air along the base of the roofline.
- During the 2021 monitoring events, a site walkover was conducted to assess the thin soil cover identified in the earlier work by Tiamat Environmental Consultants Ltd. (Tiamat), to evaluate for exposed waste and/or seepage along the riverbank. No potential exposed waste and/or seepage were identified during the site walkovers in July 2021 and November 2021.

Based on these findings, recommendations in the 2021 monitoring report were as follows:

- Reduce the groundwater monitoring and sampling program to annually at the site for another year to confirm concentrations measured to date and to monitor trends. If groundwater results remain consistent, Tetra Tech proposed to reduce the monitoring events over time, as illustrated in the table below. However, if groundwater quality drastically changes, adjustments should be made to the monitoring program accordingly.

Proposed Groundwater and Vapour Monitoring Program

Activity	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Annual Groundwater Monitoring (six wells) and Sampling (three wells)	X		X			X				X

- The groundwater monitoring and sampling program going forward should consist of water level monitoring at the six on-site monitoring wells (MW-01, MW-02, MW-03, MW-04, MW-05, and MW-203) and sampling of the three down-gradient monitoring wells (MW-03, MW-04, and MW-203) as per the proposed schedule.
- Based on the 2021 results, the risk of vapour migration was interpreted to be low and soil vapour headspace monitoring of all wells (groundwater and vapour) and on-site bathrooms was not recommended to continue.

1.2 Scope of Work

Based on the 2021 findings and recommendations, the 2022 monitoring program scope of work included the following activities:

- Conducting an annual groundwater monitoring event, including measuring groundwater levels within each monitoring well and observing monitoring well integrity.

- Conducting annual groundwater sampling of monitoring wells MW-03, MW-04, and MW-203 by:
  - Purging shallow groundwater monitoring wells and deep groundwater monitoring wells until practically dry or until a minimum of three well volumes had been removed and allowing the water levels in the wells to recover.
  - Measuring field parameters (pH, electrical conductivity [EC], and water temperature) at the time of sampling.
  - Collecting groundwater samples from each well and submitting the samples for laboratory chemical analyses.
- Conducting an annual site walkover along the riverbank to evaluate the potential for waste exposure and seepage due to bank erosion.
- Conducting monitoring well repairs, as required.
- Preparing an annual report summarizing the field activities undertaken for the year and interpreting the groundwater monitoring and analytical results and soil vapour monitoring results.

The project was completed under Tetra Tech's Limitations on the Use of this Document for conducting environment work. A copy of these conditions is provided in Appendix A.

2.0 BACKGROUND INFORMATION

2.1 General Information

The site is located within the NE and SE portions of 28-038-27 W4M, within Plan 4086EO and 3081MC. The site is zoned P1 – Parks and Recreation and is located within the McKenzie Trails Recreation Area. The site is located on the east bank of the Red Deer River, north of 67 Street and east of Riverside Drive. The Red Deer River is adjacent to the west boundary of the site and flows in a northeasterly direction. A site location plan is shown on Figure 1. The site has been redeveloped, and includes a picnic shelter, man-made pond, playground, paved walking trails, surface parking, and two year-round washroom facilities. The Phase I environmental site assessment (ESA) by Tiamat (Tiamat 2013) identified a non-potable water well as providing water for the public washroom facilities. Based on further discussions with The City, the water for the public washroom facilities is supplied by tanks, which are filled periodically by a water truck. The surrounding land use consists of Environmental Preservation District, Future Urban Development District, and Parks and Recreation District. A residential subdivision is located on the east side of the park. Natural areas of the site consist of grasses, trees, and wetlands. Figure 2 shows the site location with surrounding land use.

Additional information on the site history, historical groundwater monitoring investigations, site setting, 2019 hazard quotient calculations, and 2014 risk management plan (RMP) review can be found in Appendix B. Cross-sections that were prepared using the wells previously installed at the site in 2013 are included in Appendix C (from Tiamat 2014a). The available borehole logs for the vapour and groundwater monitoring wells are attached in Appendix F.

2.2 Conceptual Site Model Summary

The selection of comparative guidelines is based on the conceptual site model (CSM), which outlines the rationale for the selection of applicable exposure pathways and receptors at the site. This evaluation is based on guidance presented in the Alberta Tier 1 Guidelines (Alberta Environment and Protected Areas [Alberta EPA] 2022). The CSM that was developed for the site in the 2019 groundwater and soil vapour monitoring report (Tetra Tech 2020) included the following items:

- Description of identified environmental issues including a description of processes or activities undertaken at or near the site and a listing of chemicals of potential concern (COPCs) identified in earlier investigations.
- Description of known and reported historical releases, including locations and status of any subsequent ESAs and remediation.
- Identification of applicable exposure pathways and receptors.

The following table presents a summary of the relevant exposure pathways and receptors identified in the CSM.

Summary of Conceptual Site Model

Release Mechanism	COPC	Migration/Exposure Pathway	Potential Receptor
Leachate infiltration from buried waste into foundation or through cover.	Inorganic parameters and nutrients, metals, PHCs, VOCs, and other indicator parameters (i.e., biological oxygen demand [BOD] and chemical oxygen demand [COD]).	Direct soil contact.	Human users of the parkland; ecological plants and soil invertebrates.
		Groundwater ingestion (drinking water).	Domestic use aquifer (DUA) drinking water; freshwater aquatic life in the Red Deer River.
		Off-site surface migration (wind or water erosion).	Adjacent sites of more sensitive land use.
		Nutrient and energy cycling.	Microbial functioning of the soil.
Landfill gas (LFG) emissions from buried waste.	VOCs, methane, BTEX and PHC fractions, and siloxanes.	Vapour inhalation.	Human users of the parkland.
	Methane.	Accumulation to explosive levels in presence of an ignition source.	Enclosed spaces.

As recommended by Alberta EPA, the soil vapour results obtained during the 2019 investigation were evaluated using the Canadian Council of Minister of the Environment's (CCME's) document A Protocol for the Derivation of Soil Vapour Quality Guidelines for Protection of Human Exposures Via Inhalation of Vapours (CCME 2014). To determine the appropriate vapour guidelines, indoor air risk calculations were undertaken and hazard quotients were calculated. Potential explosive risk was evaluated through relative comparison of the measured concentrations to the LEL for methane (5% Gas by volume).

The CSM determined that the most applicable guidelines for groundwater and vapour results for the site were as follows:

- Groundwater concentrations at the site were compared to the Alberta Tier 1 Guidelines under residential and parkland land use for coarse-grained soils (Alberta EPA 2022).
- Soil vapour analytical results were compared to A Protocol for the Derivation of Soil Vapour Quality Guidelines for Protection of Human Exposures Via Inhalation of Vapours under residential land use for both slab-on-grade and basement for coarse-grained soils (CCME 2014).

2.3 Monitoring Well Network

The groundwater monitoring network at the site consists of six monitoring wells (MW-01 to MW-05 and MW-203). MW-03 (deep) and MW-04 (shallow) are a nested pair located in the northeast section of the site. Most of the wells are screened to the bottom of the well within the native sand and gravel. MW-05 is screened within MSW to bedrock. Monitoring well completion details are summarized in Table 1. All monitoring wells were reported to be in good condition in 2022. The vapour monitoring network consists of one vapour monitoring well (VW-01) near the southeast corner of the site. The vapour well was reported to be in good condition in 2022.

Groundwater and vapour monitoring well locations are shown on Figure 2.

3.0 MONITORING AND SAMPLING METHODOLOGY

3.1 Groundwater Monitoring and Sampling

A discussion of the methods used for the fieldwork and laboratory testing is presented in the following sections. In 2022, Tetra Tech conducted groundwater monitoring on December 6, 2022. Groundwater sampling was conducted on December 8, 2022.

3.1.1 Groundwater Monitoring and Sampling Methodology

Monitoring at the groundwater monitoring wells (51 mm diameter) consisted of measuring static groundwater levels in each monitoring well annually (December).

The methodology for monitoring and sampling at the groundwater monitoring wells included the following:

- Observing the integrity of each well and noting drainage and site conditions near the well that may have an effect on monitoring results or groundwater quality.
- Measuring liquid levels in each monitoring well with an interface probe and recording total depths confirming absence of non-aqueous phase liquids (NAPL).
- Recording of field data on standardized forms as documented in Tetra Tech standard operating practices.
- Purging each monitoring well requiring sampling using dedicated polyethylene bailers or Waterra tubing with inertial pump foot valves of at least three well volumes of water, or until the well was practically dry.

Following the completion of groundwater monitoring and purging, groundwater samples were collected from the required wells using the procedures identified below:

- Groundwater samples were collected from three monitoring wells (MW-03, MW-04, and MW-203). Samples were collected and placed into appropriate laboratory supplied, sterile glass and plastic vials and bottles for the required analytical package. Samples were filtered and/or preserved in the field, as required.
- Field measurements were taken for pH, EC, and temperature at the time of sampling.
- Samples were submitted in coolers with ice to ALS Laboratory Group (ALS) in Calgary, Alberta for laboratory analysis under a chain-of-custody (COC) documentation.

3.1.2 Groundwater Sampling Analytical Program

The analytical program for the groundwater monitoring wells was developed based on the recommendations in Section 1.1 and is summarized below:

- Routine water chemistry.
- Dissolved metals.
- VOCs.

4.0 RESULTS AND DISCUSSION

This section presents the results of the fieldwork conducted in 2022 at the site and discussions of these results.

4.1 Site Walkover

During the December 2022 monitoring event, a site walkover was conducted to assess the thin soil cover identified in the earlier work by Tiamat, to evaluate for exposed waste and/or seepage along the riverbank. No potential exposed waste and/or seepage was identified during the site walkover in December; however, the site was snow covered during the walkover. An additional site walkover was conducted in May 2023 to conduct a site walkover when the ground and riverbank were visible. No potential exposed waste and/or seepage was identified in May 2023.

4.2 Groundwater Elevations

The measured groundwater levels and calculated groundwater elevations for 2022 are presented in Table 1.

Figure 3 presents the groundwater elevation trends (hydrographs) for the groundwater monitoring wells. This figure shows the groundwater elevations in 2013, 2019, 2021, and 2022. Overall, groundwater elevations increased at most monitoring wells from those measured in 2021, with the exception of MW-03 and MW-05.

In December 2022, the average depth to groundwater in the monitoring wells was 2.49 m below grade (mbg). The groundwater elevations for December 2022 are shown on Figure 4. The groundwater elevations in 2022 indicated that the inferred groundwater flow direction was to the north-northeast, following the flow direction of the Red Deer River. The horizontal hydraulic gradient was relatively flat across a majority of the site (0.001 m/m), steepening at the north end (0.006 m/m) resulting in an average of 0.004 m/m, which is consistent with previous findings. The nested wells MW-03 and MW-04 demonstrate a modest upward hydraulic gradient.

4.3 Groundwater Field Parameters

Field measurements for temperature, pH, and EC in December 2022 are shown in Table 2. A discussion of the results of the field tests is summarized in this section.

In 2022, groundwater temperatures ranged from 5.69°C (MW-203) to 6.68°C (MW-04).

In 2022, field pH values ranged from 7.08 (MW-04) to 7.33 (MW-03). The field pH measurements were generally less than the laboratory pH at all monitoring wells. The difference between field recorded and laboratory pH values may be due to limitations of the field equipment and differences in sample temperature.

In 2022, field EC measurements ranged from 876 µS/cm (MW-203) to 1,130 µS/cm (MW-03). The field EC measurements were less than the laboratory measured EC results, which may also be due to limitations of field equipment or temperature differences.

4.4 Groundwater Analytical Results

The groundwater analytical data for 2022 is summarized in Table 2. The 2022 laboratory analytical reports are included in Appendix D. Historical data from the 2013 Phase II ESA are included in Appendix E.

4.4.1 Background Groundwater Quality

Monitoring wells MW-01 and MW-02 are hydraulically up-gradient of the site and may represent background groundwater quality. MW-01 and MW-02 were not sampled in 2022. The 2019 results at MW-01 and MW-02 suggest that both up-gradient wells had low concentrations of chloride (17.0 mg/L and 7.67 mg/L, respectively), MW-01 had guideline exceedances of dissolved arsenic, dissolved iron, and dissolved manganese and MW-02 contained concentrations of dissolved copper and dissolved manganese greater than the Tier 1 Guidelines. Concentrations of BTEX, PHC fractions F1 and F2, and VOCs were less than the analytical detection limits at MW-01 and MW-02 in 2019.

4.4.2 Routine Water Chemistry Parameters

In 2022, TDS concentrations ranged from 858 mg/L (MW-203) to 1,080 mg/L (MW-03). TDS concentrations at monitoring wells MW-03, MW-04, and MW-203 were greater than the Tier 1 Guidelines (500 mg/L) in 2022. TDS concentrations measured in 2022 were consistent with the results from 2019. Elevated TDS concentrations often occur in groundwater as a result of the dissolution of naturally occurring salts and minerals, and do not necessarily indicate groundwater quality impact related to the former landfill. Monitoring wells MW-03, MW-04, and MW-203 exhibited elevated concentrations of hardness (calcium and magnesium combined) and alkalinity with respect to the other site wells in 2019 and reported similar concentrations in 2022. Elevated concentrations of hardness and alkalinity are often observed when the groundwater quality is affected by leachate.

In 2022, concentrations of chloride at the site ranged from 22.9 mg/L at MW-203 to 41.4 mg/L at MW-03. The concentrations at all wells were less than the Tier 1 Guidelines (120 mg/L). Concentrations of chloride in 2022 were consistent with concentrations measured in 2013, 2019, and 2021.

In 2022, sodium concentrations decreased at monitoring wells MW-03 and MW-04 and increased at MW-203. The highest sodium concentration measured on site is at monitoring well MW-03. In 2021, the sodium concentration at MW-03 (207 mg/L) increased to marginally above the Tier 1 Guideline (200 mg/L), in 2022 the sodium concentration at MW-03 (190 mg/L) decreased below the guideline. The elevated sodium concentration at MW-03 may be from variations in natural salinity of the deeper groundwater and is not interpreted to be indicative of site impacts.

Ammonia concentrations at several monitoring wells adjacent to the former waste footprint have been elevated relative to monitoring wells outside the waste (e.g., MW-01 and MW-02), and often near or greater than the referenced guideline values. In 2022, monitoring wells MW-04 and MW-203 exceeded the guideline value derived in accordance with the Environmental Quality Guidelines for Alberta Surface Waters. The calculated guideline values for MW-04 was 8.50 mg-N/L and MW-203 was 9.21 mg-N/L (Government of Alberta 2018), while the measured concentrations were 11.0 mg-N/L and 14.1 mg-N/L, respectively. Groundwater near MW-203 and MW-04 is expected to ultimately discharge into the Red Deer River, as the monitoring wells are located approximately 30 m and 90 m from the river, respectively. Based on the measured concentration and the expected dilution effect when groundwater discharges, the environmental risk is considered low. The ammonia concentrations at all wells were consistent with historically measured values. Concentrations of nitrate and nitrite were less than the analytical

detection limits at most monitoring wells, except for nitrate at MW-03 (0.152 mg-N/L), which was less than the Tier 1 Guideline.

4.4.3 Dissolved Metals

Iron and manganese are redox-sensitive parameters that also naturally occur in groundwater under anaerobic conditions and can help determine whether the groundwater quality is affected by biodegradation reactions, for instance related to landfill leachate. The dissolved manganese and iron concentrations were greater than the Tier 1 Guidelines at most monitoring wells during the sampling event in 2022, with the exception of dissolved iron at MW-03.

In 2022, the concentration of dissolved selenium at MW-203 (0.00360 mg/L) was greater than the Tier 1 Guideline (0.002 mg/L). Dissolved selenium previously exceeded the Tier 1 Guideline for selenium at MW-203 in November 2021 (0.00254 mg/L). The selenium exceedance at MW-203 in 2022 is marginal, may be natural occurring, and is not considered to be of concern.

4.4.4 Organic Parameters

Concentrations of BTEX and PHC fractions F1 to F2, were less than the analytical detection limits at most locations in 2022. MW-203 had a detectable concentration of benzene in 2022 (0.00079 mg/L), marginally greater than the analytical detection limit (0.00050 mg/L). The concentration was less than the Tier 1 Guideline (0.005 mg/L) and similar to the concentration measured in 2019 and 2021.

In 2022, VOC concentrations were less than the analytical detection limits for most parameters, except for cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride at MW-03, MW-04, and MW-203. A Tier 1 Guideline value has not been established for cis-1,2-DCE. Vinyl chloride exceeded the Tier 1 Guideline at MW-03 (0.0016 mg/L), MW-04 (0.0037 mg/L), and MW-203 (0.0062 mg/L); however, the concentrations were within the same order of magnitude as the guideline (0.0011 mg/L). It should be noted that the Tier 1 Guideline for vinyl chloride is based off human vapour inhalation and there is currently no guideline pertaining to freshwater aquatic life. The VOC concentrations measured in 2022 are consistent with the concentrations measured in 2019 and 2021.

Cis-1,2-DCE is a known breakdown product of dry-cleaning liquids (i.e., tetrachloroethene [PCE] or trichloroethene [TCE]). It typically further degrades to form vinyl chloride. PCE or TCE were not detected in 2019, 2021, or 2022; however, in 2013, a PCE concentration of 0.0033 mg/L was measured at MW-05. MW-05 also contained a trace concentration (0.0007 mg/L) of vinyl chloride in 2013. As stated in Section 2.3, the well is completed within an area with MSW and was not sampled in either 2019, 2021, or 2022.

The measured concentrations of vinyl chloride and cis-1,2-DCE are indicators of MSW leachate impacting the groundwater hydraulically down-gradient from the site. Although both VOCs have consistently been detected since 2019, the concentrations are relatively low. Vinyl chloride and cis-1,2-DCE exhibit distinctly different properties. Vinyl chloride is gaseous substance with a boiling point of -13.4°C and a relatively low water solubility. Although there is evidence of carcinogenicity of vinyl chloride, owing to its high volatility, vinyl chloride has rarely been detected in surface water (World Health Organization [WHO] 2004). There is limited information on the toxicity of cis-1,2-DCE; however, the data suggest the compound has less toxicological concerns than vinyl chloride (WHO 2003). Cis-1,2-DCE is a dense liquid and when released to surface water, volatilization is expected to be the primary fate process, with a published estimated half-life of less than one day (Agency for Toxic Substances and Disease Registry [ATSDR] 1996). Based on the measured concentrations, and the published information on the properties and environmental fate of both VOCs, they are not interpreted to present a significant risk to the freshwater quality in the nearby Red Deer River.

4.5 Quality Assurance/Quality Control

4.5.1 Methods

Tetra Tech's groundwater quality assurance/quality control (QA/QC) procedures include reviewing the data collected for precision and accuracy and following the appropriate field protocols.

The field procedures for QA/QC involved:

- Changing nitrile gloves between sample collections;
- Using sample containers provided by the laboratory;
- Cleaning monitoring and sampling tools between sample locations;
- Filling sample containers for PHC analysis with no headspace (air) when the containers were closed;
- Conducting leak testing at vapour wells prior to the collection of vapour samples;
- Collecting a duplicate vapour sample during the vapour sampling event; and
- Documenting field procedures and sampling activities.

4.5.2 Results

The QA/QC results are included in Table 3. In December 2022, a duplicate sample taken at monitoring well MW-03 was submitted for analysis of the same parameters as the original sample.

The duplicate analysis is compared by relative percent difference (RPD). The RPD is calculated using the following equation:

$$\text{RPD} = \frac{(V_1 - V_2)}{\frac{(V_1 + V_2)}{2}} * 100\%$$

Where:

V_1 = Parent Sample

V_2 = Duplicate Sample

Chemical parameters were considered as having passed the QA/QC reproducibility procedure if the RPD was less than or equal to 20%, indicating a close correlation between the sample-duplicate pair.

RPD values were not calculated if one or both of the sample-duplicate concentrations were between the reportable detection limit (RDL) and five times the RDL. In these cases, chemical parameters were still considered as having passed the QA/QC reproducibility procedure if the sample duplicate concentration difference was less than one RDL value.

Duplicate RPDs were less than 20% for all the reportable concentrations. Based on the QA/QC results, the sample methods and results are considered acceptable.

5.0 EVALUATION OF SITE CONDITIONS

Based on the 2022 and historical data for the site, there is no evidence that there are significant concerns related to the former landfill operations at McKenzie Trails. However, there is evidence of residual impacts by leachate and the site does contain buried landfill waste; therefore, some risk management measures are required. Further, there are several elements of the site assessment data requiring further monitoring as detailed below.

The groundwater quality appears to be affected by leachate at several monitoring wells. Most obvious are elevated ammonia concentrations at MW-03, MW-04, and MW-203. Chloride and boron, which are often elevated in MSW leachate, did not exceed the referenced guidelines at the monitoring wells that were sampled. Two chlorinated VOCs were detected in 2022 at the down-gradient monitoring wells. One VOC compound (vinyl chloride) exceeded the referenced Tier 1 Guidelines at MW-03, MW-04, and MW-203.

The site only contains one vapour well (VW-01), which is located between the waste footprint and the building to the southeast. Methane concentrations were measured in 2019 and 2021 from VW-01 and headspace monitoring at the on-site monitoring wells. The methane concentrations measured were determined to not be of concern as methane was measured below the instrument's detection limit (0.0% Gas) at VW-01 from 2019 to 2021 and a maximum headspace concentration of 190 ppm (equivalent to 0.02% Gas) was measured at the monitoring wells (July 2021). Subsequently, headspace vapour measurements at VW-01 and the groundwater wells were removed from the 2022 annual monitoring program.

During the December 2022 monitoring event, a site walkover was conducted to assess the thin soil cover identified in the earlier work by Tiamat, to evaluate for exposed waste and/or seepage along the riverbank. No potential exposed waste and/or seepage was identified during the site walkover in December; however, the site was snow covered during the walkover. An additional site walkover was conducted in May 2023 to conduct a site walkover when the ground and riverbank were visible. No potential exposed waste and/or seepage was identified in May 2023.

The proximity of the Red Deer River warrants the groundwater flow pattern and trends in groundwater quality to continue to be monitored as outlined in Section 6.0 below.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon the results of the groundwater and soil vapour monitoring and sampling conducted in 2022 and previous years, Tetra Tech has developed the following conclusions:

- The groundwater elevations in 2022 indicated that the inferred groundwater flow direction was to the north-northeast, following the flow direction of the Red Deer River. The average horizontal hydraulic gradient at the site in December 2022 was approximately 0.004 m/m, which is consistent with previous findings.
- Routine groundwater chemistry parameters and dissolved metals that exceeded the Tier 1 Guidelines at one or more monitoring wells in 2022 included TDS, ammonia, and the dissolved metals iron, manganese, and selenium. The measured concentrations of one or more of these parameters suggest leachate has impacted the groundwater quality at MW-03, MW-04, and MW-203, each hydraulically down-gradient of the waste disposal area.

- In 2022, monitoring wells MW-04 and MW-203 contained ammonia that exceeded the guideline value derived in accordance with the Environmental Quality Guidelines for Alberta Surface Waters. The calculated guideline value for MW-04 was 8.50 mg-N/L and for MW-203 was 9.21 mg-N/L (Government of Alberta 2018), while the measured concentrations were 11.0 mg-N/L and 14.1 mg-N/L, respectively. Groundwater near MW-203 and MW-04 is expected to ultimately discharge into the Red Deer River, as the monitoring wells are located approximately 30 m and 90 m from the river, respectively. Based on the measured concentrations and the expected dilution effect when groundwater discharges, the environmental risk is considered low.
- Concentrations of BTEX and PHC fractions F1 to F2, were less than the analytical detection limits at most locations in 2022. MW-203 had a detectable concentration of benzene (0.00079 mg/L), marginally greater than the analytical detection limit (0.00050 mg/L). Concentrations of BTEX and PHC fractions F1 and F2 were less than the Tier 1 Guidelines at all locations.
- Concentrations of vinyl chloride were greater than the Tier 1 Guideline in the groundwater samples collected from MW-03, MW-04, and MW-203. Additionally, concentrations of cis-1,2-DCE were detected at MW-03, MW-04, and MW-203. The concentrations of vinyl chloride and cis-1,2-DCE measured are indicators of MSW leachate impacting the groundwater below the site. However, the concentrations of both VOCs have been consistent since 2019, the concentrations are considered low, and the VOC concentrations are not interpreted to impose a significant risk to the freshwater quality in the nearby Red Deer River.
- During the December 2022 monitoring event and in May 2023, a site walkover was conducted to assess the thin soil cover identified in the earlier work by Tiamat Environmental Consultants Ltd., to evaluate for exposed wastes and/or seepage along the riverbank. No potential exposed wastes and/or seepage was identified during the site walkover in December 2022 or May 2023. Future site walkovers should be conducted in the Spring/Summer to ensure the site is not snow covered.

Based upon the results of the groundwater monitoring program in 2022 and previous years, there are residual impacts in the groundwater and buried waste remains beneath the site; therefore, ongoing risk management is required including ongoing monitoring and administrative actions. The following recommendations are made according to these risk management elements:

- Ongoing Monitoring:
  - The groundwater results in 2022 remained consistent with previous results from 2019 and 2021. Consequently, Tetra Tech recommends following the table below that was originally proposed in the 2021 Groundwater and Soil Vapour Monitoring Report (Tetra Tech 2022a) and conducting the next annual groundwater monitoring and sampling event in 2024. The proposed frequency should be re-evaluated at the time of each event based on ongoing results evaluation.
  - It is recommended that the annual site walkover take place during the Spring/Summer to adequately assess the soil cover and the riverbank.

Proposed Groundwater Monitoring Program

Activity	2023	2024	2025	2026	2027	2028	2029	2030	2031
Annual Groundwater Monitoring (six wells; MW-01, MW-02, MW-03, MW-04, MW-05, and MW-203)		X			X				X
Annual Groundwater Sampling (three wells; MW-03, MW-04, and MW-203)		X			X				X
Annual Site Walkover in Spring/Summer		X			X				X

- Administrative Actions:
  - Utilize the revised generic mitigative measures (when evaluating applications for development within the setback).
  - Ensure that the site is clearly identified within The City's Land Use Bylaw and appropriate administrative requirements are met for the site in accordance with City policies.

Further to the above recommendations, as noted the site remains an historical landfill. It presently appears to be well maintained and capped. The City should review this status on an ongoing basis to ensure that the cover remains intact and drainage remains positive; repairs or maintenance should be undertaken as required to maintain the site.

7.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact Frans Hettinga at our Calgary office.

Respectfully submitted,
Tetra Tech Canada Inc.

Prepared by:
Ryan Miller, B.Sc.
Project Scientist
Solid Waste Management Practice
Direct Line: 403.998.4609
Ryan.Miller@tetratech.com

Reviewed by:
Frans Hettinga, B.Sc.
Principal Specialist
Solid Waste Management Practice
Direct Line: 403.723.6860
Frans.Hettinga@tetratech.com

PROFESSIONAL ENGINEER ALBERTA
SEAN D. BUCKLES
#62764
2023-06-16

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
RM SIGNATURE:
RM APEGA ID #: 62764
DATE: 2023-06-16
PERMIT NUMBER: P013774
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Reviewed by:
Sean Buckles, M.Sc., P.Eng.
Senior Project Engineer – Team Lead
Solid Waste Management Practice
Direct Line: 403.723.6876
Sean.Buckles@tetratech.com

/as

REFERENCES

Agency for Toxic Substances and Disease Registry. 1996. Toxicology Profile for 1,2-dichloroethene. Atlanta, GA.

Alberta Environment and Parks. 2022. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Government of Alberta. August 26, 2022. ISBN 978-1-4601-5501-1.

Canadian Council of Ministers of the Environment. 2014. A Protocol for the Derivation of Soil Vapour Quality Guidelines for Exposure Protection of Human Exposures via Inhalation of Vapours. Available online: http://ceqg-rcqe.ccme.ca/en/index.html#void.

Government of Alberta. 2018. Environmental Quality Guidelines for Alberta Surface Waters. Water Policy Branch, Alberta Environment and Parks. Edmonton, Alberta.

Tetra Tech Canada Inc. 2020. 2019 Groundwater and Soil Vapour Monitoring Report – McKenzie Trails Recreation Area. Prepared for The City of Red Deer. October 2020. Project Number: 704-SWM.SWOP04071-01.003.

Tetra Tech Canada Inc. 2021. 2021 Work Scope and Cost Estimate. Prepared for The City of Red Deer. March 2021. Project Number: 704-SWM.SWOP04071-01.

Tetra Tech Canada Inc. 2022a. 2021 Groundwater and Soil Vapour Monitoring Report – McKenzie Trails Recreation Area. Prepared for The City of Red Deer. June 2022. Project Number: 704-SWM.SWOP04071-02.003.

Tetra Tech Canada Inc. 2022b. 2022 Work Scope and Cost Estimate. Prepared for The City of Red Deer. October 2022. Project Number: 704-SWM.SWOP04071-02.

Tiamat Environmental Consultants Ltd. 2013. Phase I Environmental Site Assessment, Historic Waste Disposal Site, McKenzie Trails Recreation Area, The City of Red Deer. September 24, 2013.

Tiamat Environmental Consultants Ltd. 2014a. Phase II Environmental Site Assessment, Historic Waste Disposal Site, McKenzie Trails Recreation Area, The City of Red Deer. February 12, 2014.

Tiamat Environmental Consultants Ltd. 2014b. Environmental Risk Management Plan, Historic Waste Disposal Sites, McKenzie Trails Recreation Area, The City of Red Deer. November 26, 2014.

World Health Organization. 2003. 1,2-dichloroethene in Drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality. https://www.who.int/water_sanitation_health/water-quality/guidelines/chemicals/1-2-dichloroethene-background.pdf [accessed March 14, 2021].

World Health Organization. 2004. Vinyl Chloride in Drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality. https://www.who.int/water_sanitation_health/dwq/chemicals/vinylchloride.pdf [accessed March 14, 2021].

TABLES

Table 1: Monitoring Results - Groundwater Wells

Monitoring Well		MW-01	MW-02	MW-03	MW-04	MW-05	MW-203
Total Drilled Depth (m)		5.5	10.6	9.1	3.8	6.1	5.3
Top of Screened Interval (mbg)		0.9	6.9	-	-	3.1	-
Bottom of Screened Interval (mbg)		5.5	10.6	9.1	3.8	6.1	4.8
Stick up (m)		0.79	0.92	0.87	0.77	0.86	0.51
Ground Elevation (m)		848.29	849.75	847.47	847.48	849.38	848.61
TPC Elevation (m)		849.09	850.67	848.34	848.25	850.24	849.17
Depth to Groundwater (mBTPC)	Aug-13	1.71	3.10	1.56	1.55	3.69	4.12
	May-19	2.59	4.18	2.55	2.46	4.10	3.46
	Jun-19	2.63	4.01	2.40	2.29	4.11	2.96
	Sep-19	2.89	4.27	2.72	2.67	4.12	3.52
	Dec-19	2.75	3.35	2.50	2.38	4.12	2.52
	Jul-21	2.78	4.12	2.58	2.17	3.74	3.38
	Nov-21	3.15	4.38	2.59	2.51	3.78	3.70
	Dec-22	2.90	4.14	2.65	2.73	3.91	3.34
Groundwater Elevation (m)	Aug-13	847.38	847.57	846.78	846.70	846.55	845.05
	May-19	846.50	846.49	845.79	845.79	846.15	845.72
	Jun-19	846.46	846.66	845.94	845.96	846.14	846.22
	Sep-19	846.19	846.40	845.62	845.58	846.13	845.65
	Dec-19	846.34	847.32	845.84	845.87	846.12	846.65
	Jul-21	846.31	846.55	845.76	845.76	846.50	845.79
	Nov-21	845.93	846.29	845.75	845.33	846.46	845.47
	Dec-22	846.19	846.53	845.69	845.52	846.33	845.83
Volatile Organic Compounds* (VOCs) (ppm)	May-19	ND	ND	ND	ND	ND	ND
	Jun-19	ND	ND	ND	ND	ND	ND
	Sep-19	ND	ND	ND	ND	ND	ND
	Dec-19	ND	1	1	1	1	1
Combustible Vapour Concentrations* (CVCs) (ppm)	May-19	ND	ND	ND	ND	ND	ND
	Jun-19	ND	ND	ND	ND	ND	ND
	Sep-19	35	15	ND	ND	170	100
	Dec-19	ND	20	ND	ND	5	20
Methane Concentrations** (ppm)	Jul-21	190	15	190	ND	45	ND
	Nov-21	5	10	ND	ND	50	ND

Notes:

mbg - Metres below grade.

mBTPC - Metres below top of plastic pipe casing.

ppm - Parts per million.

ND - Non-detect.

- Unavailable.

*- Measured using an RKI Eagle II calibrated to hexane (CVCs) and isobutylene (VOCs) and operated in methane elimination mode.

**- Measured using an RKI Eagle II calibrated to methane.

Table 2: Groundwater Analytical Results

Parameter	Unit	Tier 1 Guideline [1,2]	MW-01	MW-02	MW-03 (Deep Well)			MW-04			MW-203		
			4-Dec-2019	4-Dec-2019	4-Dec-2019	21-Nov-2021	08-Dec-2022	4-Dec-2019	21-Nov-2021	08-Dec-2022	5-Dec-2019	21-Nov-2021	08-Dec-2022
Field													
Field Temperature	°C	-	2.90	5.42	2.64	7.88	5.98	2.67	6.63	6.68	1.15	5.72	5.69
Field Electric Conductivity	µS/cm	-	434	381	1,017	1,564	1,130	973	1,521	1,043	510	1,062	876
Field pH	pH Units	6.5 to 8.5	**8.53**	7.98	7.48	7.22	7.33	7.25	7.04	7.08	7.64	6.76	7.11
Routine													
pH	pH Units	6.5 to 8.5	8.13	8.22	7.77	7.85	7.77	7.53	7.71	7.62	8.03	7.79	7.71
Electrical Conductivity (EC)	µS/cm	-	617	559	1,680	1,690	1,660	1,660	1,700	1,610	1,030	1,410	1,350
Total Dissolved Solids (TDS)	mg/L	500	378	333	**1,090**	**1,100**	**1,080**	**1,010**	**1,080**	**1,040**	**633**	**803**	**858**
Hardness as $CaCO_3$	mg/L	-	289	269	646	537	544	664	714	668	437	421	529
Alkalinity (total as $CaCO_3$)	mg/L	-	337	255	934	937	934	872	939	920	510	743	735
Bicarbonate	mg/L	-	411	311	1,140	1,140	1,140	1,060	1,140	1,120	622	906	896
Carbonate	mg/L	-	<5.0	<5.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0
Hydroxide	mg/L	-	<5.0	<5.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0
Calcium	mg/L	-	71.7	72.2	168	144	134	168	185	162	119	110	130
Magnesium	mg/L	-	26.8	21.6	55.0	43.0	50.8	59.3	61.1	64.0	33.9	35.5	49.7
Potassium	mg/L	-	4.27	2.70	9.68	8.04	8.49	20.7	18.9	19.3	13.8	13.0	13.7
Sodium	mg/L	200	40.1	16.4	174	**207**	190	96.6	113	110	47.1	64.8	80.2
Chloride	mg/L	120	17.0	7.67	49.6	43.2	41.4	42.9	29.4	28.1	19.5	24.0	22.9
Fluoride	mg/L	1.5	0.094	0.086	<0.10	<0.100	0.157	<0.10	<0.100	0.233	<0.10	<0.100	0.218
Phosphorus - Total	mg/L	-	0.412	0.0202	0.273	-	-	0.568	-	-	0.35	-	-
Sulphate	mg/L	429 [3]	16.0	59.6	69.5	64.4	69.6	94.7	71.4	64.8	93.2	78.3	85.3
Anions Total (Filtered)	meq/L	-	-	-	-	21.3	21.3	-	21.1	20.5	-	17.2	17.1
Cations Total (Filtered)	meq/L	-	-	-	-	20.4	19.8	-	20.7	19.6	-	12.5	15.5
Ionic Balance	N/A	-	102	94.0	98.6	104.4	93.0	91.1	102	95.6	95.2	138	90.6
Nutrients													
Ammonia as N	mg/L	0.309 to 15.73 [6]	0.477	<0.050	**7.00**	5.51	5.57	**10.4**	**11.2**	**11.0**	**13.3**	12.9	**14.1**
Nitrate (as NO_3-N)	mg/L	3	<0.020	<0.020	<0.10	<0.100	0.152	0.17	0.301	<0.100	<0.10	0.121	<0.100
Nitrite (as NO_2-N)	mg/L	0.08 to 0.20 [4]	<0.010	<0.010	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nitrate and Nitrite (as N)	mg/L	-	<0.022	<0.022	<0.11	-	0.152	0.17	-	<0.112	<0.11	-	<0.112
Total Kjeldahl Nitrogen (TKN)	mg/L	-	1.29	0.23	8.2	-	-	13.3	-	-	15	-	-
Carbon													
Dissolved Organic Carbon (DOC)	mg/L	-	5.4	4.6	11.4	-	-	20.7	-	-	9.5	-	-
Dissolved Metals													
Aluminum	mg/L	0.050 [5]	0.0033	0.0074	<0.0050	0.0069	0.0036	0.0348	<0.0050	0.0036	0.0035	0.0080	0.0060
Antimony	mg/L	0.006	0.00014	0.00013	<0.00050	<0.00050	<0.00010	<0.00050	<0.00050	0.00012	<0.00010	<0.00050	<0.00010
Arsenic	mg/L	0.005	**0.00828**	0.00029	0.00137	0.00158	0.00130	0.00440	**0.00618**	0.00398	**0.00796**	0.00209	0.00396
Barium	mg/L	2	0.421	0.152	0.309	0.371	0.360	0.253	0.278	0.277	0.188	0.211	0.243
Beryllium	mg/L	-	-	-	-	<0.000100	-	-	<0.000100	-	-	<0.000100	-
Bismuth	mg/L	-	-	-	-	<0.000250	-	-	<0.000250	-	-	<0.000250	-
Boron	mg/L	1.5	0.024	0.016	0.875	0.907	0.791	0.977	1.47	1.06	0.494	0.617	0.534
Cadmium	mg/L	0.00036 to 0.00037 [3]	<0.0000050	0.000148	<0.000025	0.0000286	0.0000830	0.0000830	0.000120	0.0000098	0.0000408	<0.0000250	<0.0000050
Chromium	mg/L	0.05	<0.00010	<0.00010	<0.00050	<0.00250	<0.00050	<0.00050	<0.00250	<0.00050	0.00015	<0.00250	<0.00050
Cobalt	mg/L	-	-	-	-	0.00225	-	-	0.00444	-	-	<0.00050	-
Copper	mg/L	0.007	<0.00020	**0.00719**	0.0052	<0.00100	0.00051	<0.0010	<0.00100	0.00134	<0.00020	<0.00100	<0.00020
Iron	mg/L	0.3	**3.09**	0.041	0.123	**0.534**	0.029	**3.85**	**5.34**	**3.70**	**2.23**	**0.680**	**0.753**
Lead	mg/L	0.0070 [3]	<0.000050	0.000219	<0.00025	<0.000250	<0.000050	<0.00025	<0.000250	<0.000050	<0.000050	<0.000250	<0.000050
Lithium	mg/L	-	-	-	-	0.0499	-	-	0.0304	-	-	0.0169	-
Manganese	mg/L	0.02	**0.861**	**0.0843**	**1.02**	**0.780**	**0.796**	**1.16**	**1.16**	**1.06**	**0.303**	**0.297**	**0.358**
Mercury	mg/L	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum	mg/L	-	-	-	-	0.00100	-	-	0.00259	-	-	<0.000250	-
Nickel	mg/L	0.120 to 0.275 [3]	0.00192	0.00099	0.0171	0.00532	0.00467	0.0093	0.00910	0.0112	0.00054	0.00307	0.00182
Phosphorus	mg/L	-	-	-	-	<0.250	-	-	<0.250	-	-	0.977	-
Selenium	mg/L	0.002	0.000104	0.000132	<0.00025	<0.000250	0.000063	<0.00025	<0.000250	0.000064	0.000242	**0.00254**	**0.00360**
Silicon	mg/L	-	-	-	-	6.45	-	-	7.02	-	-	4.84	-
Silver	mg/L	0.0001	<0.000010	<0.000010	<0.000050	<0.000050	<0.000010	<0.000050	<0.000050	<0.000010	<0.000010	<0.000050	<0.000010
Strontium	mg/L	-	-	-	-	1.80	-	-	1.81	-	-	1.21	-
Sulphur	mg/L	-	-	-	-	27.6	-	-	29.7	-	-	19.1	-
Thallium	mg/L	-	-	-	-	<0.000050	-	-	<0.000050	-	-	<0.000050	-
Tin	mg/L	-	-	-	-	<0.00050	-	-	<0.00050	-	-	<0.00050	-
Titanium	mg/L	-	-	-	-	<0.00150	-	-	<0.00150	-	-	<0.00150	-
Uranium	mg/L	0.015	0.000733	0.000851	0.00242	0.00238	0.00212	0.00297	0.00351	0.00291	0.00059	0.000228	0.000473
Vanadium	mg/L	-	-	-	-	<0.00250	-	-	<0.00250	-	-	<0.00250	-
Zinc	mg/L	0.03	<0.0010	0.0058	0.0247	0.0054	0.0021	0.0097	0.0087	0.0028	0.0011	<0.0050	0.0019
Zirconium	mg/L	-	-	-	-	0.00141	-	-	<0.00100	-	-	<0.00100	-

Notes:

[1] Alberta Environment and Protected Areas (AEPA). 2022. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Land Policy Branch, Policy and Planning Division. 198 pp. Referenced guidelines are for coarse-textured soils under Residential/Parkland land use.

[2] Alberta Environment and Parks (AEP). Environmental Quality Guidelines for Alberta Surface Waters. March 2018. Table 1 Surface water quality guidelines for the protection of freshwater aquatic life (FAL). Most conservative values applied (chronic or acute).

[3] Guideline varies with hardness. Values shown based on site hardness range of 269 mg/L to 714 mg/L.

[4] Guideline varies with chloride. Values shown based on site chloride range of 7.70 mg/L to 49.6 mg/L.

[5] Guideline varies with pH. Values shown based on site pH range of 6.76 to 8.53.

[6] Guideline varies with pH and temperature. Values shown based on pH range of 6.76 to 8.53 and temperature range of 1.15°C to 7.88°C.

"-" No applicable guideline or not analyzed.

"ND" Non-detected.

BOLD - Greater than Tier 1 Guideline.

N/A - Not applicable.

Table 2: Groundwater Analytical Results

Parameter	Unit	Tier 1 Guideline [1,2]	MW-01	MW-02	MW-03 (Deep Well)			MW-04			MW-203		
			4-Dec-2019	4-Dec-2019	4-Dec-2019	21-Nov-2021	08-Dec-2022	4-Dec-2019	21-Nov-2021	08-Dec-2022	5-Dec-2019	21-Nov-2021	08-Dec-2022
Organics													
AOX	mg/L	-	ND	ND	ND	-	-	ND	-	-	ND	-	-
Hydrocarbons													
Benzene	mg/L	0.005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00053	0.00058	0.00079
Toluene	mg/L	0.021	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Ethylbenzene	mg/L	0.0016	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Xylenes (m & p)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.00030	<0.00030	<0.00050	<0.00030	<0.00030	<0.00050	<0.00030	<0.00030
Xylene (o)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.00040	<0.00040	<0.00050	<0.00040	<0.00040	<0.00050	<0.00040	<0.00040
Xylenes Total	mg/L	0.02	<0.00071	<0.00071	<0.00071	<0.00050	<0.00050	<0.00071	<0.00050	<0.00050	<0.00071	<0.00050	<0.00050
Styrene	mg/L	0.072	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
F1 (C_6-C_{10})	mg/L	-	<0.10	<0.10	<0.10	-	-	<0.10	-	-	<0.10	-	-
F1 (C_6-C_{10}) - BTEX	mg/L	0.81	<0.10	<0.10	<0.10	-	-	<0.10	-	-	<0.10	-	-
F2 (C_{10}-C_{16})	mg/L	1.1	<0.10	<0.10	<0.10	-	-	<0.10	-	-	<0.10	-	-
Total BTEX	mg/L	-	-	-	-	<0.0010	<0.0010	-	<0.0010	<0.0010	-	<0.0010	<0.0010
Volatile Fatty/Carboxylic Acids													
Acetic Acid	mg/L	-	<10	<10	<10	-	-	<10	-	-	<10	-	-
Butyric Acid	mg/L	-	<1.0	<1.0	<1.0	-	-	<1.0	-	-	<1.0	-	-
Formic Acid	mg/L	-	<50	<50	<50	-	-	<50	-	-	<50	-	-
Hexanoic Acid	mg/L	-	<1.0	<1.0	<1.0	-	-	<1.0	-	-	<1.0	-	-
iso-Butyric Acid	mg/L	-	<1.0	<1.0	<1.0	-	-	<1.0	-	-	<1.0	-	-
Isovaleric Acid	mg/L	-	<1.0	<1.0	<1.0	-	-	<1.0	-	-	<1.0	-	-
Propanoic Acid	mg/L	-	<5.0	<5.0	<5.0	-	-	<5.0	-	-	<5.0	-	-
Valeric Acid	mg/L	-	<1.0	<1.0	<1.0	-	-	<1.0	-	-	<1.0	-	-
Polycyclic Aromatic Hydrocarbons (PAHs)													
Naphthalene	mg/L	0.001	-	-	-	<0.0010	-	-	<0.0010	-	-	<0.0010	-
Volatile Organic Compounds (VOCs)													
Bromobenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Bromochloromethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Bromodichloromethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
Bromoform	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
Bromomethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
n-Butylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
sec-Butylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
tert-Butylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Carbon tetrachloride	mg/L	0.00029	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chlorobenzene	mg/L	0.0013	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
Chloroethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Chloroform	mg/L	0.018	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
Chloromethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.0010	<0.0050	<0.0050	<0.0010	<0.0050	<0.0050
2-Chlorotoluene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
4-Chlorotoluene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dibromochloromethane	mg/L	0.19	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
1,2-Dibromo-3-chloropropane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,2-Dibromoethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
Dibromomethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
1,2-Dichlorobenzene	mg/L	0.0007	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
1,3-Dichlorobenzene	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
1,4-Dichlorobenzene	mg/L	0.001	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
1,1-Dichloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
1,2-Dichloroethane	mg/L	0.005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,1-Dichloroethene	mg/L	0.014	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
1,2-Dichloroethene (cis)	mg/L	-	<0.0010	<0.0010	0.0036	0.0042	0.0049	0.0083	0.0077	0.0102	0.0083	0.0098	0.0106
1,2-Dichloroethene (trans)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
Dichlorodifluoromethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
1,2-Dichloropropane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010

Notes:

[1] Alberta Environment and Protected Areas (AEPA). 2022. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Land Policy Branch, Policy and Planning Division. 198 pp. Referenced guidelines are for coarse-textured soils under Residential/Parkland land use.

2 Alberta Environment and Parks (AEP). Environmental Quality Guidelines for Alberta Surface Waters. March 2018. Table 1 Surface water quality guidelines for the protection of freshwater aquatic life (FAL). Most conservative values applied (chronic or acute).

[3] Guideline varies with hardness. Values shown based on site hardness range of 269 mg/L to 714 mg/L.

[4] Guideline varies with chloride. Values shown based on site chloride range of 7.70 mg/L to 49.6 mg/L.

[5] Guideline varies with pH. Values shown based on site pH range of 6.76 to 8.53.

[6] Guideline varies with pH and temperature. Values shown based on pH range of 6.76 to 8.53 and temperature range of 1.15°C to 7.88°C.

"-" No applicable guideline or not analyzed.

"ND" Non-detected.

BOLD - Greater than Tier 1 Guideline.

N/A - Not applicable.

Table 2: Groundwater Analytical Results

Parameter	Unit	Tier 1 Guideline [1,2]	MW-01	MW-02	MW-03 (Deep Well)			MW-04			MW-203		
			4-Dec-2019	4-Dec-2019	4-Dec-2019	21-Nov-2021	08-Dec-2022	4-Dec-2019	21-Nov-2021	08-Dec-2022	5-Dec-2019	21-Nov-2021	08-Dec-2022
Volatile Organic Compounds (VOCs)													
1,3-Dichloropropane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
2,2-Dichloropropane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,1-Dichloropropene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,3-Dichloropropene	mg/L	-	-	-	-	<0.0015	<0.0015	-	<0.0015	<0.0015	-	<0.0015	<0.0015
1,3-Dichloropropene [cis]	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
1,3-Dichloropropene [trans]	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Hexachlorobutadiene	mg/L	0.0013	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
p-Isopropyltoluene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Methyl t-Butyl Ether (MTBE)	mg/L	0.015	-	-	-	<0.00050	<0.00050	-	<0.00050	<0.00050	-	<0.00050	<0.00050
Methylene Chloride	mg/L	0.05	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
iso-Propylbenzene (cumene)	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
n-Propylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,1,1,2-Tetrachloroethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,1,2,2-Tetrachloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
Tetrachloroethene	mg/L	0.01	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
1,2,3-Trichlorobenzene	mg/L	0.008	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,2,4-Trichlorobenzene	mg/L	0.015	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,1,1-Trichloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
1,1,2-Trichloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
Trichloroethene	mg/L	0.00032	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
Trichlorofluoromethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Trihalomethanes	mg/L	0.1	-	-	-	<0.0020	<0.0020	-	<0.0020	<0.0020	-	<0.0020	<0.0020
1,2,3-Trichloropropane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010
1,2,4-Trimethylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,3,5-Trimethylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Vinyl chloride	mg/L	0.0011	<0.00050	<0.00050	0.00070	**0.0021**	**0.0016**	**0.00643**	**0.0032**	**0.0037**	**0.00289**	**0.0046**	**0.0062**

Notes:

[1] Alberta Environment and Protected Areas (AEPA). 2022. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Land Policy Branch, Policy and Planning Division. 198 pp. Referenced guidelines are for coarse-textured soils under Residential/Parkland land use.

[2] Alberta Environment and Parks (AEP). Environmental Quality Guidelines for Alberta Surface Waters. March 2018. Table 1 Surface water quality guidelines for the protection of freshwater aquatic life (FAL). Most conservative values applied (chronic or acute).

[3] Guideline varies with hardness. Values shown based on site hardness range of 269 mg/L to 714 mg/L.

[4] Guideline varies with chloride. Values shown based on site chloride range of 7.70 mg/L to 49.6 mg/L.

[5] Guideline varies with pH. Values shown based on site pH range of 6.76 to 8.53.

[6] Guideline varies with pH and temperature. Values shown based on pH range of 6.76 to 8.53 and temperature range of 1.15°C to 7.88°C.

"-" No applicable guideline or not analyzed.

"ND" Non-detected.

BOLD - Greater than Tier 1 Guideline.

N/A - Not applicable.

Table 3: Groundwater Quality Assurance/Quality Control Analytical Results

Parameter	Unit	RDL	MW-03 (Deep Well)		RPD (%)
			08-Dec-2022	08-Dec-2022 DUP	
Routine					
pH	pH Units	0.1	7.77	7.75	0.3
Electrical Conductivity (EC)	µS/cm	1	1,660	1,650	1
Total Dissolved Solids (TDS)	mg/L	1	1,080	1,100	2
Hardness as $CaCO_3$	mg/L	0.5	544	570	5
Alkalinity (total as $CaCO_3$)	mg/L	1	934	937	0.3
Bicarbonate	mg/L	1	1,140	1,140	0
Carbonate	mg/L	1	<1.0	<1.0	-
Hydroxide	mg/L	1	<1.0	<1.0	-
Calcium	mg/L	0.05	134	145	8
Magnesium	mg/L	0.005	50.8	50.4	1
Potassium	mg/L	0.05	8.49	8.8	4
Sodium	mg/L	0.05	190	192	1
Chloride	mg/L	2.5	41.4	40.2	3
Fluoride	mg/L	0.1	0.157	0.123	-
Sulphate	mg/L	1.5	69.6	69.2	1
Anions Total (Filtered)	meq/L	0.1	21.3	21.3	0
Cations Total (Filtered)	meq/L	0.1	19.8	20.4	3
Ionic Balance	N/A	0.01	93	95.8	3
Nutrients					
Ammonia as N	mg/L	0.125	5.57	5.52	1
Nitrate (as NO_3-N)	mg/L	0.1	0.152	<0.100	-
Nitrite (as NO_2-N)	mg/L	0.05	<0.050	<0.050	-
Nitrate and Nitrite (as N)	mg/L	0.112	0.152	<0.112	-
Dissolved Metals					
Aluminum	mg/L	0.001	0.0036	0.0039	-
Antimony	mg/L	0.0001	<0.00010	<0.00010	-
Arsenic	mg/L	0.0001	0.0013	0.0012	8
Barium	mg/L	0.0001	0.36	0.366	2
Boron	mg/L	0.01	0.791	0.818	3
Cadmium	mg/L	0.000005	0.000083	0.0000861	4
Chromium	mg/L	0.0005	<0.00050	<0.00050	-
Copper	mg/L	0.0002	0.00051	0.00041	-
Iron	mg/L	0.01	0.029	0.029	-
Lead	mg/L	0.00005	<0.000050	<0.000050	-
Manganese	mg/L	0.0001	0.796	0.81	2
Mercury	mg/L	0.000005	<0.0000050	<0.0000050	-
Nickel	mg/L	0.0005	0.00467	0.00466	0.2
Selenium	mg/L	0.00005	0.000063	0.000285	-
Silver	mg/L	0.00001	<0.000010	<0.000010	-
Uranium	mg/L	0.00001	0.00212	0.00234	10
Zinc	mg/L	0.001	0.0021	0.0013	-
Hydrocarbons					
Benzene	mg/L	0.0005	<0.00050	<0.00050	-
Toluene	mg/L	0.0005	<0.00050	<0.00050	-
Ethylbenzene	mg/L	0.0005	<0.00050	<0.00050	-
Xylenes (m & p)	mg/L	0.0003	<0.00030	<0.00030	-
Xylene (o)	mg/L	0.0004	<0.00040	<0.00040	-
Xylenes Total	mg/L	0.0005	<0.00050	<0.00050	-
Styrene	mg/L	0.0005	<0.00050	<0.00050	-
Total BTEX	mg/L	0.001	<0.0010	<0.0010	-
Volatile Organic Compounds (VOCs)					
Bromobenzene	mg/L	0.001	<0.0010	<0.0010	-
Bromochloromethane	mg/L	0.001	<0.0010	<0.0010	-
Bromodichloromethane	mg/L	0.001	<0.0010	<0.0010	-
Bromoform	mg/L	0.001	<0.0010	<0.0010	-
Bromomethane	mg/L	0.001	<0.0010	<0.0010	-
n-Butylbenzene	mg/L	0.001	<0.0010	<0.0010	-
sec-Butylbenzene	mg/L	0.001	<0.0010	<0.0010	-
tert-Butylbenzene	mg/L	0.001	<0.0010	<0.0010	-
Carbon tetrachloride	mg/L	0.0005	<0.00050	<0.00050	-
Chlorobenzene	mg/L	0.001	<0.0010	<0.0010	-
Chloroethane	mg/L	0.001	<0.0010	<0.0010	-
Chloroform	mg/L	0.001	<0.0010	<0.0010	-
Chloromethane	mg/L	0.005	<0.0050	<0.0050	-
2-Chlorotoluene	mg/L	0.001	<0.0010	<0.0010	-
4-Chlorotoluene	mg/L	0.001	<0.0010	<0.0010	-
Dibromochloromethane	mg/L	0.001	<0.0010	<0.0010	-
1,2-Dibromo-3-chloropropane	mg/L	0.001	<0.0010	<0.0010	-
1,2-Dibromoethane	mg/L	0.001	<0.0010	<0.0010	-
Dibromomethane	mg/L	0.001	<0.0010	<0.0010	-

Table 3: Groundwater Quality Assurance/Quality Control Analytical Results

Parameter	Unit	RDL	MW-03 (Deep Well)		RPD (%)
			08-Dec-2022	08-Dec-2022 DUP	
1,2-Dichlorobenzene	mg/L	0.0005	<0.00050	<0.00050	-
1,3-Dichlorobenzene	mg/L	0.001	<0.0010	<0.0010	-
1,4-Dichlorobenzene	mg/L	0.001	<0.0010	<0.0010	-
1,1-Dichloroethane	mg/L	0.001	<0.0010	<0.0010	-
1,2-Dichloroethane	mg/L	0.001	<0.0010	<0.0010	-
1,1-Dichloroethene	mg/L	0.001	<0.0010	<0.0010	-
1,2-Dichloroethene (cis)	mg/L	0.001	0.0049	0.0053	-
1,2-Dichloroethene (trans)	mg/L	0.001	<0.0010	<0.0010	-
Dichlorodifluoromethane	mg/L	0.001	<0.0010	<0.0010	-
1,2-Dichloropropane	mg/L	0.001	<0.0010	<0.0010	-
1,3-Dichloropropane	mg/L	0.001	<0.0010	<0.0010	-
2,2-Dichloropropane	mg/L	0.001	<0.0010	<0.0010	-
1,1-Dichloropropene	mg/L	0.001	<0.0010	<0.0010	-
1,3-Dichloropropene	mg/L	0.0015	<0.0015	<0.0015	-
1,3-Dichloropropene [cis]	mg/L	0.001	<0.0010	<0.0010	-
1,3-Dichloropropene [trans]	mg/L	0.001	<0.0010	<0.0010	-
Hexachlorobutadiene	mg/L	0.001	<0.0010	<0.0010	-
p-Isopropyltoluene	mg/L	0.001	<0.0010	<0.0010	-
Methyl t-Butyl Ether (MTBE)	mg/L	0.0005	<0.00050	<0.00050	-
Methylene Chloride	mg/L	0.001	<0.0010	<0.0010	-
iso-Propylbenzene (cumene)	mg/L	0.001	<0.0010	<0.0010	-
n-Propylbenzene	mg/L	0.001	<0.0010	<0.0010	-
1,1,1,2-Tetrachloroethane	mg/L	0.001	<0.0010	<0.0010	-
1,1,2,2-Tetrachloroethane	mg/L	0.001	<0.0010	<0.0010	-
Tetrachloroethene	mg/L	0.001	<0.0010	<0.0010	-
1,2,3-Trichlorobenzene	mg/L	0.001	<0.0010	<0.0010	-
1,2,4-Trichlorobenzene	mg/L	0.001	<0.0010	<0.0010	-
1,1,1-Trichloroethane	mg/L	0.001	<0.0010	<0.0010	-
1,1,2-Trichloroethane	mg/L	0.001	<0.0010	<0.0010	-
Trichloroethene	mg/L	0.001	<0.0010	<0.0010	-
Trichlorofluoromethane	mg/L	0.001	<0.0010	<0.0010	-
Trihalomethanes	mg/L	0.002	<0.0020	<0.0020	-
1,2,3-Trichloropropane	mg/L	0.001	<0.0010	<0.0010	-
1,2,4-Trimethylbenzene	mg/L	0.001	<0.0010	<0.0010	-
1,3,5-Trimethylbenzene	mg/L	0.001	<0.0010	<0.0010	-
Vinyl chloride	mg/L	0.001	0.0016	0.0016	-

Notes:

RDL - Reportable detection limit.

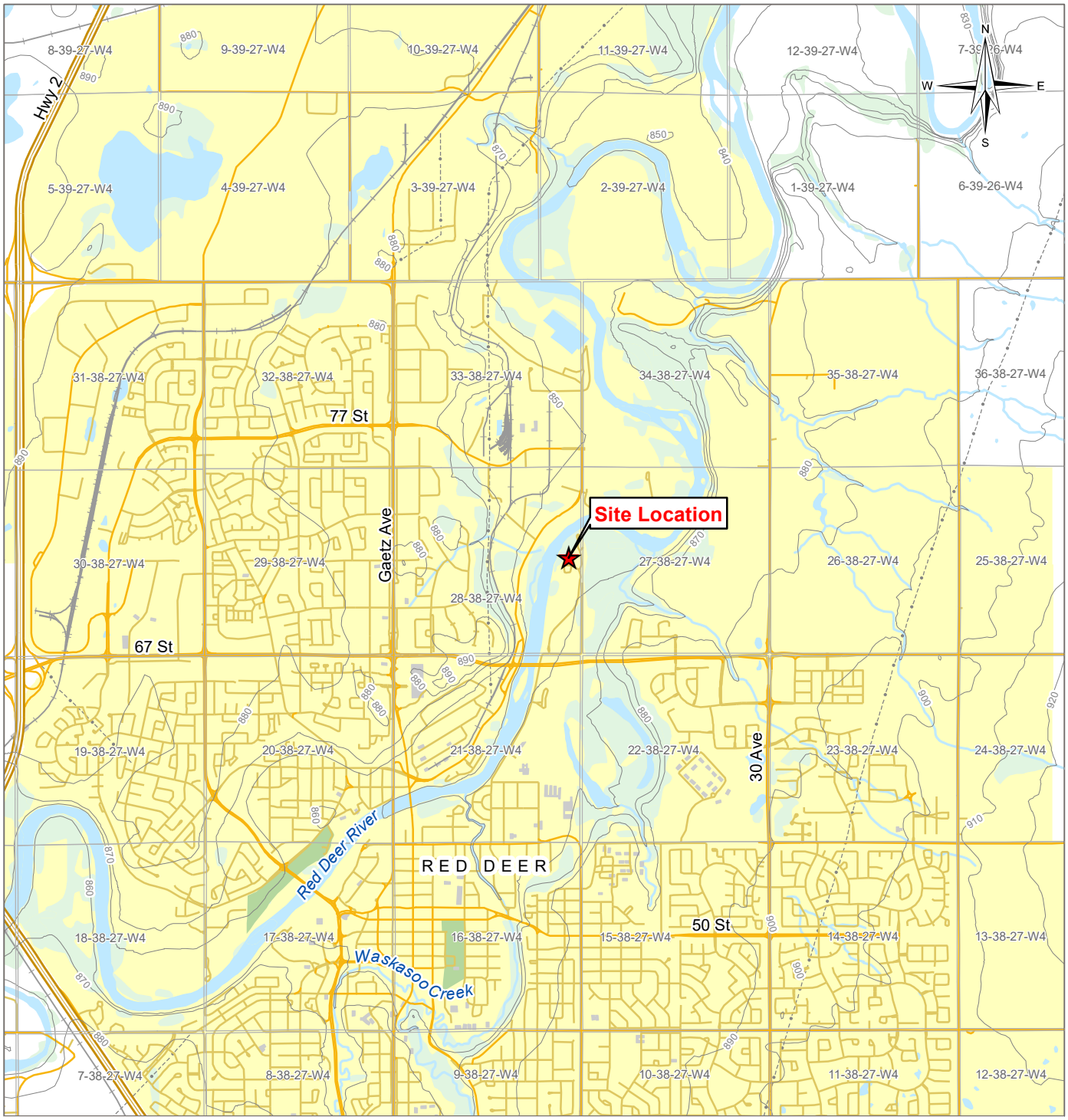
RPD - Relative Percentage Difference calculated as RPD(%)=(|V1-V2|)/[(V1+V2)/2])*100 where V1,V2 = concentrations of parent and duplicate sample, respectively.

"-" Indicates RPD not calculated. RPDs have only been considered where both concentrations are greater than 5 times the RDL.

N/A - Not applicable.

BOLD - RPD value greater than 20%.

FIGURES



LEGEND

- Site Location
- Highway
- Main Road
- Local Road
- Resource/Recreational Road
- Railway
- Power Line
- Building
- Park
- Residential Area
- Contour (10 m)
- Watercourse
- Waterbody
- Wooded Area
- Urban Area

NOTES
Base data source: CanVec 1:50,000.

STATUS
ISSUED FOR USE

2022 GROUNDWATER MONITORING REPORT MCKENZIE TRAILS RECREATION AREA

Site Location Plan

PROJECTION	DATUM	CLIENT
3TM 114	NAD83	The City of Red Deer

Scale: 1:50,000
1 0.5 0 1
Kilometres

FILE NO. SWOP04071-03_Figure1_SiteLocation.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-EDM	SL	MRB	RM	0

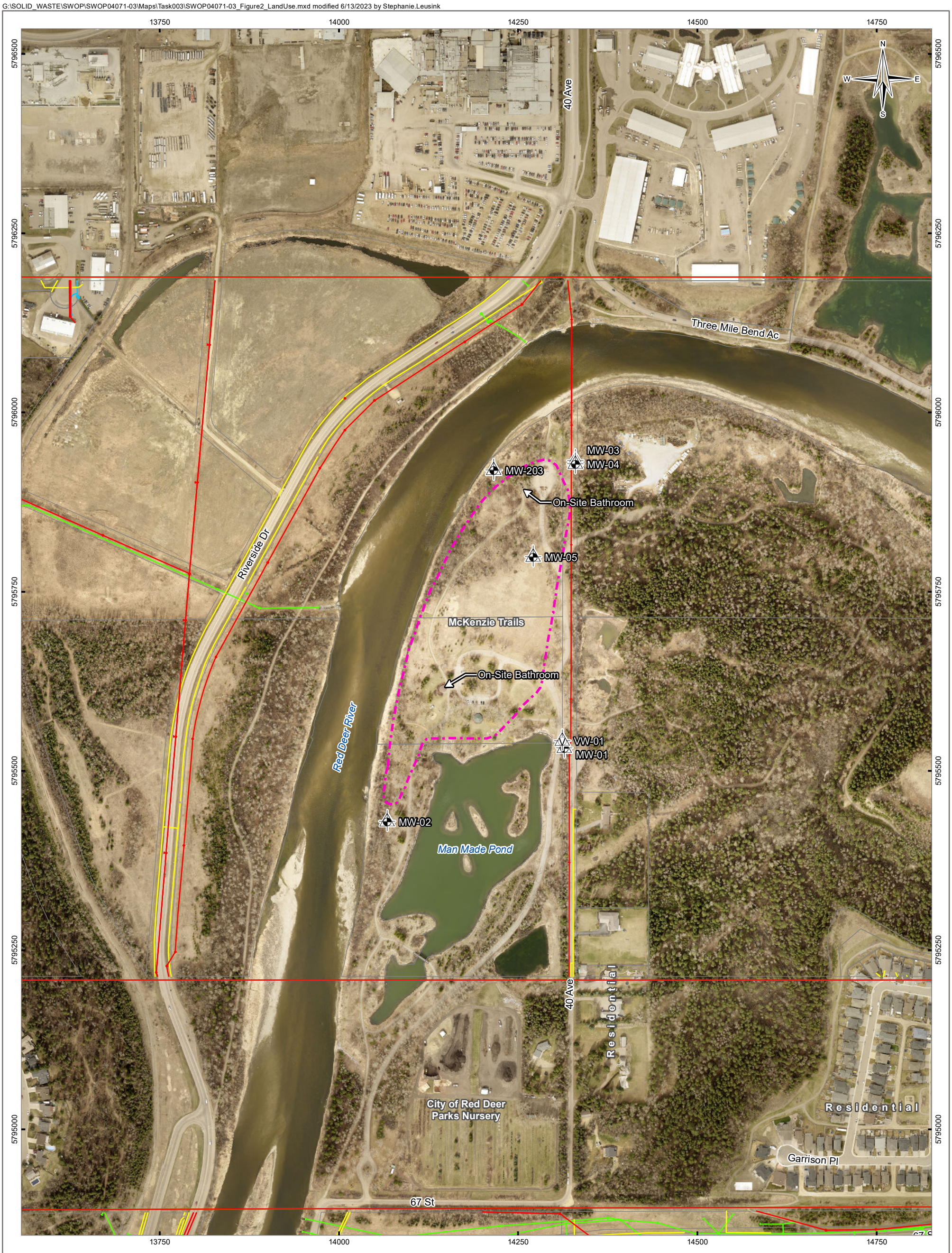
DATE	PROJECT NO.
June 13, 2023	SWM.SWOP04071-03.003

TETRA TECH

Figure 1

Q:\Edmonton\GIS\SOLID_WASTE\SWOP\SWOP04071-03\Maps\Task003\SWOP04071-03_Figure1_SiteLocation.mxd modified 2/21/2023 by stephanie.leusink

G:\SOLID_WASTE\SWOP\SWOP04071-03\Maps\Task003\SWOP04071-03_Figure2_LandUse.mxd modified 6/13/2023 by Stephanie.Leusink



LEGEND

- Monitoring Well
- Vapour Well
- Historic Waste Disposal (Provided by Tiamat, 2014)
- Lot Boundary

Utilities

- Electrical
- Sanitary
- Storm
- Water

NOTES

Base data source: Imagery provided by City of Red Deer (2022)
Roads from City of Red Deer Open Data, 2018
Utilities provided by City of Red Deer.
Locations have not been field verified, and should not be used for construction or other intrusive field activities.

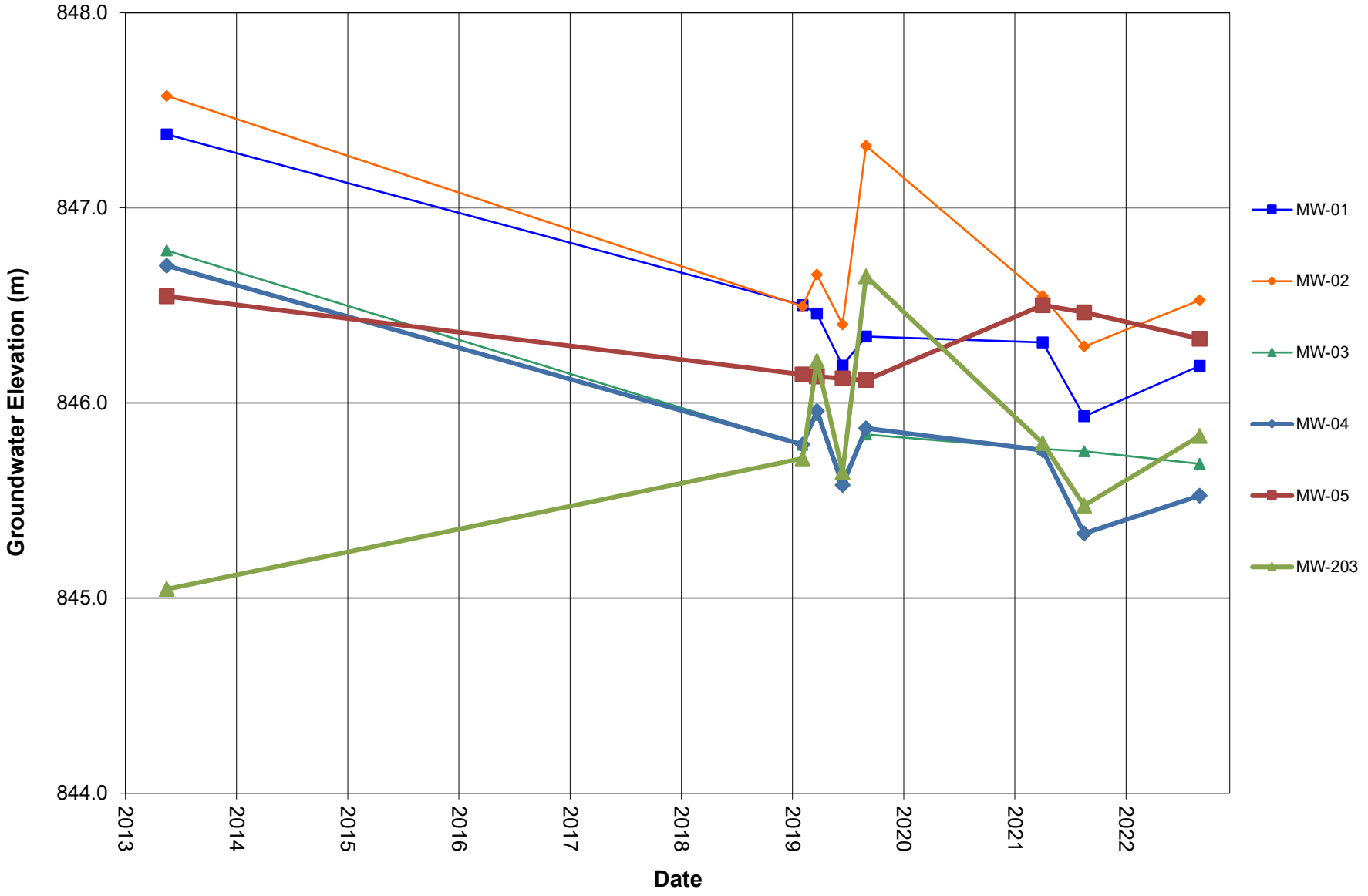
STATUS
ISSUED FOR USE

2022 GROUNDWATER MONITORING REPORT MCKENZIE TRAILS RECREATION AREA

Site Plan and Surrounding Land Use

PROJECTION 3TM 114	**DATUM** NAD83			**CLIENT** THE CITY OF Red Deer
Scale: 1:5,000 — 100 50 0 100 Metres				TETRA TECH
FILE NO. SWOP04071-03_Figure2_LandUse.mxd				
OFFICE Tt-EDM	**DWN** SL	**CKD** MRB	**APVD** RM	**REV** 0
DATE June 13, 2023	**PROJECT NO.** SWM.SWOP04071-03.003			**Figure 2**

FIGURE 3
GROUNDWATER MONITORING WELL HYDROGRAPHS



G:\SOLID_WASTE\SWOP\SWOP04071-03\Maps\Task003\SWOP04071-03_Figure4_GW_Dec2022.mxd modified 6/13/2023 by Stephanie.Leusink

LEGEND

- Monitoring Well
- Vapour Well
- Groundwater Flow Direction
- Groundwater Elevation Contour (0.25 masl)
- (84X.XX) Groundwater Elevation (measured on December 6, 2022; masl)
- (84X.XX)* Groundwater Elevation (not contoured; masl)
- Historic Waste Disposal (Provided by Tiamat, 2014)
- Road

NOTES
Base data source: Imagery provided by City of Red Deer (2022)
Roads from City of Red Deer Open Data, 2018
masl - metres above sea level

STATUS
ISSUED FOR USE

2022 GROUNDWATER MONITORING REPORT MCKENZIE TRAILS RECREATION AREA

Groundwater Elevation Contours December 2022

PROJECTION: 3TM 114	DATUM: NAD83			CLIENT: The City of Red Deer
Scale: 1:2,000 (40 20 0 40 Metres)				TETRA TECH
FILE NO.: SWOP04071-03_Figure4_GW_Dec2022.mxd				
OFFICE: Tt-EDM	DWN: SL	CKD: MRB	APVD: RM	REV: 0
DATE: June 13, 2023	PROJECT NO.: SWM.SWOP04071-03.003			Figure 4

APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOENVIRONMENTAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by TETRA TECH in its reasonably exercised discretion.

APPENDIX B

SITE HISTORY, HISTORICAL INFORMATION, SITE SETTING, 2019 HAZARD QUOTIENTS, AND 2014 RISK MANAGEMENT PLAN REVIEW

SITE HISTORY, HISTORICAL INFORMATION, SITE SETTING, 2019 HAZARD QUOTIENTS, AND 2014 RISK MANAGEMENT PLAN REVIEW

Section 1.0 to Section 4.0 are a summary from the 2019 Groundwater and Soil Vapour Monitoring Report – McKenzie Trails Recreation Area[1].

1.0 SITE HISTORY

Municipal records indicate that the waste disposal at the site occurred in two phases. Disposal in the southern portion occurred from 1930 to 1959 (approximately 29 years) and in the northern portion from 1960 to 1964 (approximately 4 years). The estimated age of the waste material post closure of the landfill is interpreted to be 55 to 60 years. Historical information indicates the waste as being municipal solid waste (MSW) including a mixture of plastics, cans, paper, scrap metals, wires, and glass. Bricks, wood, and ash were also encountered during the Phase II investigation[2].

Historical waste disposal was identified during the 2014 Phase II environmental site assessment (ESA) to be north of the man-made pond area. The waste area extends to the north end of the recreation area and to the west towards the Red Deer River. The Phase II ESA estimated the total area of buried waste at approximately 64,250 m^2. The status of the former landfill is inactive and closed.

Results of the 2014 Phase II ESA conducted by Tiamat Environmental Consultants Ltd. (Tiamat) indicate that surface material of sod and loam was overlying the buried MSW material. There were no indications of a formal barrier layer (e.g., clay) overlying the waste. The thickness of the layer or sod and loam varied between 8 cm and 15 cm. The MSW was mixed with fill consisting of sand, gravel, silt, and clay, located below the sod to a depth of approximately 5 m in the north-central area of the site. A portion of the waste material consists of burned garbage. The waste material was overlying silt (fill), sand and gravel (native), and siltstone (bedrock) in the northwest to southeast and the MSW was overlying silty sand (fill), sand and gravel (native), and siltstone and shale (bedrock) in the northeast to southwest with some clay (till) in the southwest. The base of the MSW material is similar to the level of the adjacent Red Deer River.

2.0 HISTORICAL GROUNDWATER MONITORING AND INVESTIGATION SUMMARY

Alberta Environment[3] (AENV) installed monitoring wells in 1982, including seven groundwater monitoring wells within and beside the waste material boundary. In June 2013, the Red Deer River experienced flooding and the west side of the site was impacted. Groundwater monitoring wells located on the east riverbank were damaged or destroyed, with the exception of MW-203.

[1] Tetra Tech Canada Inc. 2020. 2019 Groundwater and Soil Vapour Monitoring Report – McKenzie Trails Recreation Area. Prepared for The City of Red Deer. October 2020. Project Number: 704-SWM.SWOP04071-01.003.

[2] Tiamat Environmental Consultants Ltd. 2014a. Phase II Environmental Site Assessment, Historic Waste Disposal Site, McKenzie Trails Recreation Area, The City of Red Deer. February 12, 2014.

[3] Currently Alberta Environment and Protected Areas (AEPA).

Previous reports prepared by Tiamat for the site include the following:

- Phase I ESA, Historic Waste Disposal Site, McKenzie Trail, The City of Red Deer. September 24, 2013[4].
- Phase II ESA, Historic Waste Disposal Site, McKenzie Trails Recreation Area, The City of Red Deer. February 12, 2014[2].
- Environmental Risk Management Plan (RMP), Historic Waste Disposal Sites, McKenzie Trails Recreation Area, The City of Red Deer. November 26, 2014[5].

Two testholes (TH-03 and TH-04) were advanced in June 2013 as part of the Phase II ESA; one vapour well (VW-01) and one monitoring well (MW-01) were installed.

The results of the Phase II ESA conducted by Tiamat in 2014 indicated the following:

- There were no obvious activities that pose a high potential to adversely impact the site from activities on adjacent developments. The historical waste area is within the boundaries of the park.
- The waste area underlies the park space north of the man-made pond and extends to a setback from the Red Deer River. The plan area of the waste was calculated to be approximately 64,520 m^2, calculated from aerial photography and site observations based on topography.
- Groundwater samples demonstrated a varying level of contamination for petroleum hydrocarbons (PHCs), volatile organic compounds (VOCs), and chlorinated hydrocarbons.

A soil vapour sample indicated VOCs, aliphatic and aromatic hydrocarbons, and siloxanes. The concentrations were considered trace to low and not identified as an environmental concern to the residential developments southeast of the area.

The recommendations of the program were as follows:

- Monitor groundwater elevations and soil vapour data quarterly for one hydrogeological cycle.
- Determine if surface water sampling should be included along with additional groundwater monitoring locations to determine exposure from leachate contaminants.
- Collect an additional set of soil vapour and groundwater analytical data, groundwater elevations, and volatile headspace measurement during the winter months to determine seasonal changes in soil vapour concentrations.
- Develop a RMP to consider future land uses and address environmental concerns.
- Review all data to update the RMP with new information.

The results of the subsequent RMP conducted by Tiamat in 2014 indicated the following:

- Information in the preliminary quantitative risk assessment (PQRA) should be updated as new site information is obtained.
- A review of the RMP should be completed when the PQRA information is updated if there are changes to the chemicals of potential concern (COPCs).
- The RMP should be reviewed and updated at five-year intervals.

[4] Tiamat Environmental Consultants Ltd. 2013. Phase I Environmental Site Assessment, Historic Waste Disposal Site, McKenzie Trail, The City of Red Deer. September 24, 2013.

[5] Tiamat Environmental Consultants Ltd. 2014. Environmental Risk Management Plan, Historic Waste Disposal Sites, McKenzie Trails Recreation Area, The City of Red Deer. November 26, 2014.

3.0 SITE SETTING

The following section presents an overview of the regional and local setting for the site.

3.1 Geology

The following sections summarize the regional and local geology.

3.1.1 Geological Setting and Stratigraphy

The following description of regional geological setting was obtained from Tiamat's 2013 Phase I report[4]:

"The City of Red Deer and area are located within the Red Deer River drainage basin in the western Alberta Plains. The Red Deer River valley is the principal drainage way. The fertile black soil in the region (Penhold Loam) is of alluvial lacustrine origin. The Penhold Loam is a well-drained fine sandy loam classified as Chernozemic. It is generally stone free and in natural areas, is typically 1.5 m thick, more or less.

The local topography is characterized with gentle slopes bordered on the east and west by uplands and incised at its lowest part by the valley of the Red Deer River. The Tertiary bedrock consists of sequences of alternating shales and sandstones of the Paskapoo Formation whereas the Quaternary deposits consist of drift deposits of clay, silt, gravel and sand. Published information indicates the banks of the Red Deer River comprise of dirty gravel with thickness ranging from 6 to 12 m, more or less. The Paskapoo Formation underlies the gravel sediments. This non-marine bedrock is composed of mudstone, siltstone and sandstone. The formation of the Rocky Mountains subjected the Paskapoo Formation to a regional stress-induced fracture pattern.

Generally, the fracture pattern resembles a series of vertical fractures that trend southwest to northeast, perpendicular to the Rocky Mountains. A report from the Alberta Energy and Utilities Board EUB/AGS Earth Sciences Report 2002-04, suggest the pattern of fractures may be complemented with sub-horizontal fractures resulting from conjugate fracture patterns, differential stress release or pressure release events. In the valley, lies preglacial Saskatchewan gravels and sand. Terrace gravels hydraulically connected to the Red Deer River are a known groundwater resource.

Surficial soils comprise largely of poorly to moderately sorted sand, silt and gravel with a varying amount of clay. The fluvial sediments generally have obscure bedding planes. Medium to coarse sized gravel with cross-bedded sand have been documented."

3.1.2 Local Geology

Based on the findings from the 2014 Phase II ESA, McKenzie Trails Park consisted of 8 cm to 15 cm of sod and loam overlying municipal solid waste. The MSW is overlying a mix of silt (fill), sand and gravel (native), and siltstone and shale (bedrock). The maximum depth of waste encountered was approximately 6 m. There are no indications of a prepared landfill foundation (e.g., compacted clay liner) based on the drilling logs.

Mapping by the Alberta Geological Survey[6] indicates that a buried valley could be present approximately 300 m east of the site trending in a north-northeast direction; however, the width of the valley is not defined.

[6] Andriashek, L. comp. (2018): Thalwegs of bedrock valleys, Alberta (GIS data, line features); Alberta Energy Regulator, AER/AGS Digital Data 2018-0001.

3.2 Hydrogeology

The following sections summarize the regional and local hydrogeology.

3.2.1 Regional Hydrogeology

The following description is taken from regional hydrogeology information from Tiamat's 2013 Phase I report[4]:

"A significant buried valley and aquifer resource trending northeastward through the city has been partially mapped and lies in the SE 28-38-27 W4M (MacKenzie Trail and Riverside). This buried valley extends to a depth of 21 m, more or less and may extend to the south into north portions of 21-28-27 W4M."

"The dominant type of near-surface groundwater in the Paskapoo Formation in the area of assessment is sodium bicarbonate. Notable concentrations of sodium sulfate type groundwater have also been reported. The quality of groundwater for potable use is generally suitable to depths of 300 m on the west side of Red Deer and decreases to 90 m, more or less in the east.

Areas of recharge (downward flow) in unsaturated heterogeneous sediments include most areas above the river and creek valleys, whereas; the river valleys will generally exhibit discharge. The distribution of groundwater in the area can also be influenced by the local geology, topographic relief, areas of artesian flow, springs and reasonable yielding water source wells.

Numerous permanent surface water features within The City of Red Deer and vicinity include Red Deer River, Waskasoo Creek, Gaetz Lakes, Hazlett Lake, Bower Ponds (result of formerly mining gravel resources), various sloughs in the fringe areas of the city and an assortment of other smaller creeks and springs. These water bodies can be relevant to the environmental sensitivity of the site assessment."

There is a hydrologic relation between the gravel deposit and the Red Deer River. Depending on local sediments and flow dynamics, some sections of the Red Deer River may experience an influent flow pattern and river water may enter the gravel beds and remain as riverbank storage. The bank storage is typically gradually released when the river becomes effluent, usually between July and August. These seasonal fluctuations of the river level have notable influences with the magnitude and direction of groundwater. Discharges generally occur at some point downstream from the point of entry.

The regional groundwater generally follows the bedrock topography. It should be noted that local topography, geology, land development, and soil disturbances may influence the local movement and pattern of groundwater and in conjunction; groundwater levels may fluctuate seasonally and in response to climatic conditions. The shallow pattern of flow can also be influenced by the physical attributes of the fluvial sediments and the glacially formed Red Deer River Valley.

3.2.2 Local Hydrogeology

The Red Deer River is located on the west and north sides of McKenzie Trails Park and flows in a northerly direction. Shallow groundwater is assumed to flow towards or parallel to the river. A man-made pond is located in the central portion of McKenzie Trails Park, south of the closed landfill, and collects some of the site drainage.

3.3 Groundwater Resource Usage

A search of the Alberta Water Well Database conducted in January 2020 for groundwater users within a 1 km radius of the McKenzie Trails area identified 65 groundwater wells; 24 of the wells are listed as domestic use, two are listed as domestic and stock use, 21 are listed as investigation, two are listed as injection use, eight are listed as industrial use, three are listed as "other", one as observation use, and four are listed as unknown use[7].

The nearest water well identified through the Water Well Database to site is located approximately 100 m west of site and the Red Deer River. The proposed well use was for investigation purposes. The water wells within a 1 km radius of site range from 2.4 m to 190 m deep. The status and use of the surrounding groundwater wells were not confirmed, and they were not field verified.

4.0 HAZARD QUOTIENTS

4.1 2019 Hazard Quotient Calculations

Using the soil vapour screening levels described above and the soil vapour sampling results, estimated cancer risks (for carcinogens) and estimated hazard quotients (HQs; for non-carcinogens) were calculated for the site.

Estimated risks were calculated by dividing the soil vapour concentration by the corresponding soil vapour screening level for carcinogenic effects and multiplying the ratio by the target risk level of 1 x 10^{-5}. Similarly, the estimated HQs represent the soil vapour concentration divided by the corresponding soil vapour screening level for non-carcinogenic effects.

Risk estimates for non-carcinogenic COPCs are defined as HQ. HQs are calculated based on a ratio of the estimated exposure and the toxicity reference values identified as the tolerable daily intake (TDI) or tolerable concentration (TC) according to the following equation:

$$\text{Hazard Quotient} = \frac{\text{Estimated Daily Dose (mg/kg-day or mg/m}^3\text{)}}{\text{Tolerable Daily Intake (mg/kg-day) or Tolerable Concentration (mg/m}^3\text{)}}$$

Non-carcinogenic risk characterization in the assessment was completed for all COPCs.

When the HQ is greater than the target risk value, the scenario poses a potential concern and requires further evaluation or risk management. It is important to note that HQs greater than the target risk value do not necessarily indicate that adverse health effects will occur. This is because of the conservative assumptions used in estimating concentrations and in setting the target values. HQs that are less than the target risk value indicate that exposure is within acceptable levels and no further risk management is necessary. HQs greater than the target risk value suggest that further investigation or risk management (e.g., remediation) may be warranted.

For non-carcinogens, the cumulative target risk value used was 1.0. This target risk value accounts for additional exposure to the chemicals of concern from sources other than the site. Therefore, the cumulative target risk value of 1.0 represents an allocation of 20% of a person's daily exposure from site sources and the remaining 80% would come from other sources. Other sources of exposure include ambient air, household products, and soil and water contact from locations other than the site.

[7] Alberta Environment and Parks. 2019b. Water Well Database. Information obtained http://www.telusgeomatics.com/tgpub/ag_water/.

For carcinogens, the risk of cancer is assumed to be proportional to dose with the assumption that any exposure results in a nonzero probability of risk. Carcinogenic risk probabilities were calculated by multiplying the estimated exposure level by the route-specific cancer slope factor (SF) or unit risk factor (URF) for each carcinogen:

$$R = E \times SF \text{ (or URF)}$$

Where:

R = Estimated individual excess lifetime cancer risk;

E = Exposure level for each chemical of potential concern (mg/kg/day or mg/m^3); and

SF = Route- and chemical-specific SF $(mg/kg/day)^{-1}$ or URF $((mg/m^3)^{-1})$.

Risk probabilities determined for each carcinogen were also considered to be additive over all exposure pathways so that an overall risk of cancer was estimated for each group of potentially exposed receptors.

When assessing risks posed by exposure to carcinogenic substances, Health Canada and other regulatory agencies assume that any level of exposure is associated with some hypothetical cancer risk. As a result, it is necessary for regulatory agencies to specify an acceptable risk level. Per Health Canada guidance (2010a, 2010b), cancer risks are deemed essentially negligible where the estimated cumulative incremental lifetime cancer risk is less than or equal to 1 in 100,000 (1×10^{-5}).

For this evaluation, target risk and hazard levels were determined in accordance with the Alberta Tier 2 Guidelines. For carcinogens, the cumulative target risk level is 1×10^{-5}, as this value is considered by Health Canada to represent a negligible risk. For non-carcinogens a cumulative target hazard level of 1 is used as potential exposures that result in hazard indices equal to or less than 1 signify negligible potential for adverse health effects. Each sampling location was screened individually for every chemical detected.

A cumulative risk level for carcinogens was not calculated as none of the carcinogenic parameters were detected greater than the laboratory detection limits. A cumulative hazard level identified in the sample and its duplicate collected for the non-carcinogens ranged between 0.001 to 0.003.

The estimated cumulative risks and hazards associated with the soil vapour samples collected in December 2019 did not exceed the corresponding target risk and hazard levels.

4.2 Review of the 2014 Hazard Quotients from the Risk Management Plan

The following section is a review of the 2014 RMP[5] for the site that was completed by Tiamat. The review of the 2014 RMP was completed for the 2019 groundwater and soil vapour monitoring report[1].

The 2014 RMP presented a proposed site-specific environmental risk management plan as a tool to assist with the review of future subdivision applications on lands lying within the regulated setback distance from the site (300 m). The focus was on potential ingress of soil gas for COPCs with a HQ greater than 1.0. Residential land use was considered most sensitive, and exposure ratings for other land uses (e.g., school, public institutions, commercial complexes) were considered to not be greater than residential; however, unique exceptions would have to be reviewed and addressed on a site-specific basis[5]. Further, underground utility workers and subsurface utility infrastructure were considered relevant to potential exposure.

The RMP applied a 10x factor of safety to the HQs to address uncertainties. HQs from the RMP ranged up to 566 (including the 10x factor of safety). Based on these, the RMP then provided recommended generic mitigative measures based on the calculated HQs, ranging from passive to active measures, recognizing that the ultimate approach would require a design professional for the proposed development.

Following the 2014 RMP, Canadian Council of Minister of the Environment (CCME) released the document A Protocol for the Derivation of Soil Vapour Quality Guidelines for Protection of Human Exposures Via Inhalation of Vapours[8], designed to provide guidance for developing site-appropriate soil vapour quality guidelines. The guidelines developed using the methods outlined in the CCME document were used for this current study and are included with the vapour sampling results in Table 4. HQs were calculated using estimated dose (based on concentrations measured at the site) and divided by tolerable daily intake. Soil vapour concentrations from the Phase II ESA conducted in 2013 were not compared to soil vapour quality guidelines; however, spot checks of five target compounds with the highest HQs in the 2013 work (benzene, tetrachloroethylene, chloromethane, 1,2,4--trimethylbenzene, and styrene) identified that none of the 2013 concentrations would have unacceptable HQs using the updated CCME methodology.

The 2014 RMP was prepared concurrent to RMPs at several other former City landfills, and a common set of mitigative measures was applied based on the HQs. Subsequent to the 2014 RMP and to the release of the CCME Protocol document, The City undertook additional assessment at another former City Landfill (Montfort); as part of that work, their consultant XCG Consulting Limited (XCG) revised the 2014 RMP criteria ranges for each generic mitigative measure category to include a Cancer Risk range to allow comparison of the 2014 RMP ranges with the HQ and Cancer Risks calculated by XCG[9]. From that work, XCG identified the following generic mitigative measures for developments within a 300 m setback of these landfills (based on Tiamat 2014), and these have been adopted for this site:

Passive Measures

1. Passive Measures – Level A: for Cancer Risk of > $1E^{-5}$ and < $5E^{-5}$ and/or HQ >0.2 and <1.

   Compacted clay liner with a minimum thickness of 1 m and confirmed maximum hydraulic conductivity of 10^{-6} cm/sec.

2. Passive Measures – Level B: for Cancer Risk of > $5E^{-5}$ and < $5E^{-4}$ and/or HQ >1 and <5.

   Synthetic liner with type of material, thickness, and installation details dependent on the design professional.

3. Passive Measures – Level C: for Cancer Risk of > $5E^{-4}$ and < $1E^{-3}$ and/or HQ >5 and <50.

   Passive sub-slab depressurization (SSD) system with a minimum depressurization of 4 Pa to 10 Pa. In some instances (such as a pervious subgrade), the actual depressurization necessary may require an active SSD or alternative active ventilation system.

Active Measures

Field verify the presence of the identified chemicals of concern and other potential chemicals in the soil gas state at the development site. If confirmed, determine the most appropriate manner to prevent soil vapour intrusion.

1. Active Measures – Level D: for Cancer Risk of > $1E^{-3}$ and < $2E^{-3}$ and/or HQ values >50 and <100.

   Active SSD must be configured to compensate for depressurization of the building and have adequate negative pressure gradients across the entire footprint of the foundation.

2. Active Measures – Level E: for Cancer Risk of >$2E^{-3}$ and/or HQ values >100.

   Installation of geomembrane and active soil vapour extraction with system fault notification alarm.

[8] Canadian Council of Ministers of the Environment. 2014. A Protocol for the Derivation of Soil Vapour Quality Guidelines for Exposure Protection of Human Exposures via Inhalation of Vapours. Available online: http://ceqg-rcqe.ccme.ca/en/index.html#void.

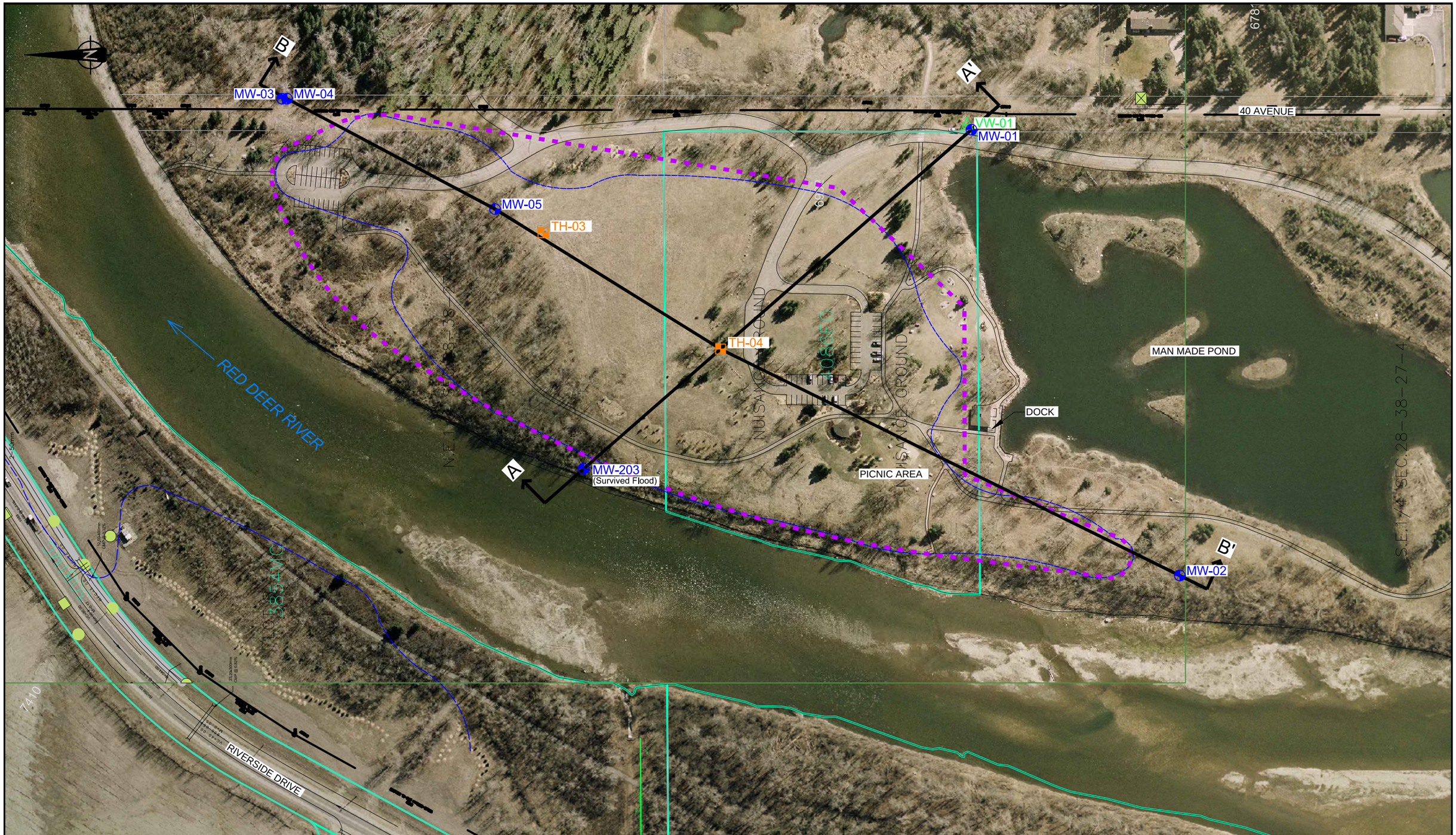
[9] XCG Consulting Limited, 2018. Vapour Intrusion Assessment and Environmental Monitoring Report, prepared for the City of Red Deer's Montfort Landfill.

For consistency with XCG's approach from 2017, we compared individual HQs with the individual target hazard level (0.2). Based on the 2019 program, the greatest HQ calculated for the site was 0.001 (vs. target individual hazard level of 0.2) and the estimated cancer risk was not calculated as no carcinogenic parameters were detected above the detection limits. The greatest cumulative HQ calculated for the site was 0.003 (vs. target cumulative hazard level of 1.0). While development at the site is not currently proposed, for illustrative purposes, based on these HQs calculated from the 2019 vapour data, no passive or active measures would be required for the site. It is noted that even if the 10x factor of safety is applied, mitigative measures would still not be required. It should also be notes that assumptions made in the calculations of HQs and cancer risk above are inherently conservative; therefore, applying a factor of safety is not needed.

Future applications for development within the setback are subject to review by The City. The developer's team would be responsible for reviewing and verifying the available data relative to their proposed development. The mitigative measures presented above are generic and can be used as a general guide for expectations by The City; ultimately, the developer's design engineer would be responsible for developing measures specific to the intended development based on the above or an appropriate equivalent. Protection of workers (e.g., construction and utility) should form part of any development plan.

APPENDIX C

CROSS-SECTIONS (TIAMAT 2014A)



SOURCE
2010 ORTHOGRAPHIC IMAGE © COPYRIGHT WITH PERMISSION FROM THE CITY OF RED DEER.

0 20 50 100m
Scale 1:2000

PHASE II TEST LOCATIONS
MW-## GROUNDWATER MONITORING WELL (5)
TH-## TESTHOLE (2)
VP-## SOIL VAPOUR MONITORING WELL (1)
REFER TO TABLE 1 FOR TESTHOLE INFORMATION

LEGEND
HISTORIC WASTE DISPOSAL
LOT BOUNDARY
100 YEAR FLOOD LINE
CROSS SECTION LOCATION
ELECTRICAL
SANITARY
STORM
WATER

NOTE:
LOCATION OF BURIED UTILITIES ARE APPROXIMATE, ACTUAL LOCATIONS OF THE SHALLOW UTILITIES AND ANY OTHER UTILITIES SHOULD BE VERIFIED PRIOR TO ANY GROUND DISTURBANCE ACTIVITY.

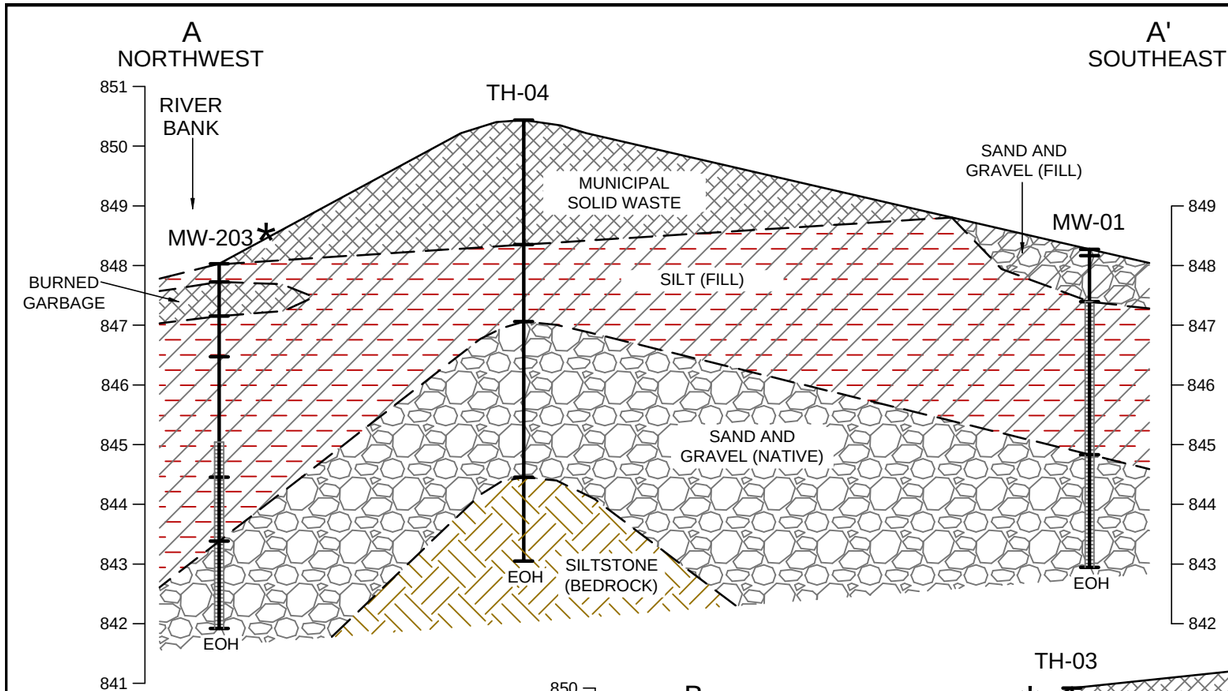
CLIENT: THE CITY OF RED DEER

PROJECT: ENVIRONMENTAL RISK MANAGEMENT PLAN
HISTORIC WASTE DISPOSAL SITE
McKENZIE TRAILS RECREATION AREA

TITLE: SITE PLAN SHOWING INTERPRETED EXTENT OF WASTE

Tiamat Environmental Consultants Ltd.

SCALE:	DATE:	PROJECT NO.:	FIGURE NO.:
1 : 2000	June 24/14	12-435	FIGURE 2
DRAWN BY: LCH	CHECKED BY: LTM	CAD FILE NO.: ERMP v1.00.dwg	

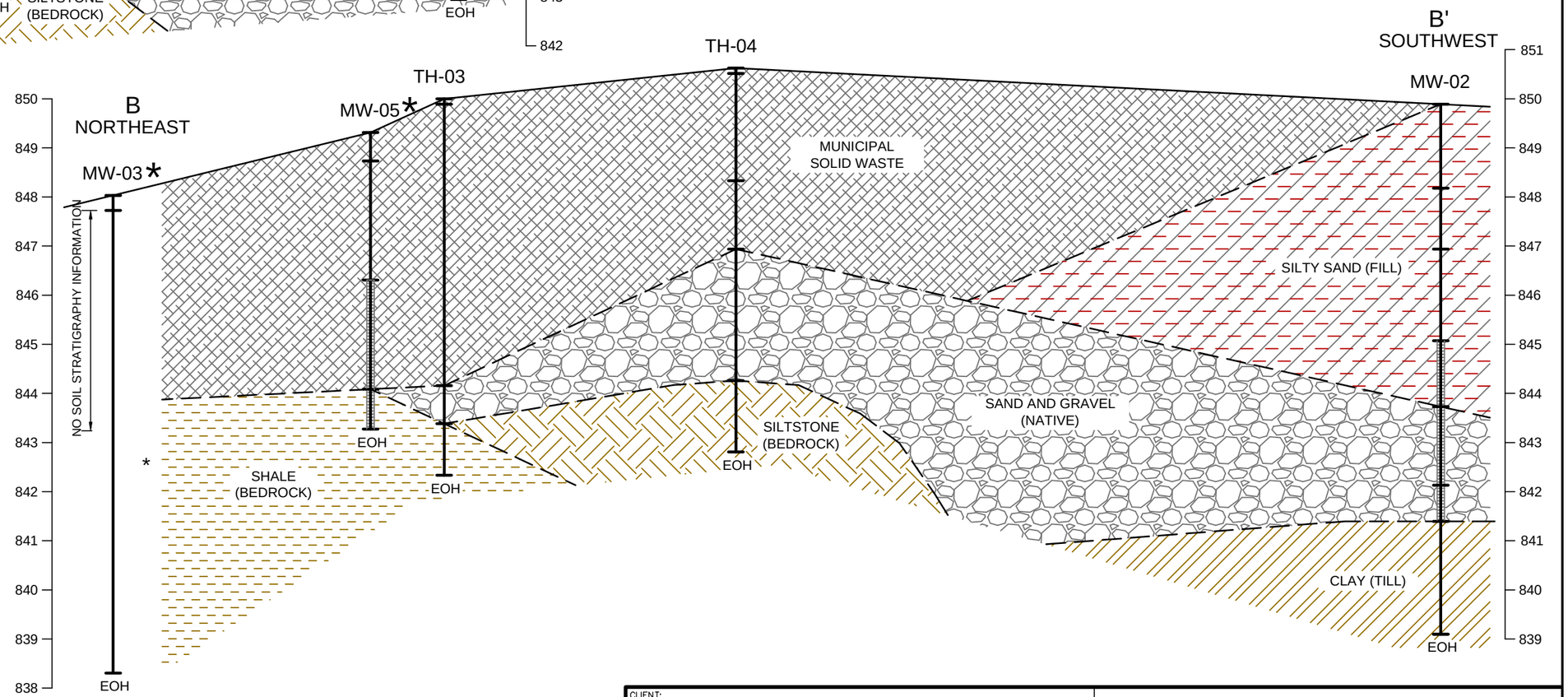


NOTES:

* SOIL DESCRIPTORS TAKEN FROM ALBERTA ENVIRONMENT 'RED DEER OLD GARBAGE DUMP' DECEMBER 1982

RIVERBANK AND MW-203 ELEVATION DETERMINED USING CONTOURS MAP

MW-203 WAS DESTROYED DURING JUNE 2013 FLOOD



0 2 5 10m
Vertical Scale 1:200

0 20 50 100m
Horizontal Scale 1:2000

NOTE:
THE GEOLOGIC AND STRATIGRAPHIC SECTIONS SHOWN ON THIS DRAWING ARE INTERPRETED FROM BOREHOLE LOGS. STRATIGRAPHY IS KNOWN WITH CERTAINTY ONLY AT THE BOREHOLE LOCATIONS. ACTUAL STRATIGRAPHY AND GEOLOGIC CONDITIONS BETWEEN BOREHOLES MAY VARY FROM THAT INDICATED ON THIS DRAWING.

CLIENT:	THE CITY OF RED DEER
PROJECT:	ENVIRONMENTAL RISK MANAGEMENT PLAN HISTORIC WASTE DISPOSAL SITE McKENZIE TRAILS RECREATION AREA
TITLE:	CROSS SECTIONS A - A' AND B - B'

Tiamat Environmental Consultants Ltd.

SCALE:	DATE:	PROJECT NO.:	FIGURE NO.:
AS SHOWN	Jan. 30/15	12-435	FIGURE 3
DRAWN BY: LCH	CHECKED BY: LTM	CAD FILE NO.: ERMP Sections v1.01	

APPENDIX D

LABORATORY ANALYTICAL REPORT

CERTIFICATE OF ANALYSIS

Work Order	: **CG2217088**	Page	: 1 of 6
Client	: **Tetra Tech Canada Inc.**	Laboratory	: Calgary - Environmental
Contact	: Darby Madalena	Account Manager	: Patryk Wojciak
Address	: 110, 140 Quarry Park Blvd SE Calgary AB Canada T2C 3G3	Address	: 2559 29th Street NE Calgary AB Canada T1Y 7B5
Telephone	: 403 203 3355	Telephone	: +1 403 407 1800
Project	: SWM.SWOP04071-03.003	Date Samples Received	: 12-Dec-2022 08:00
PO	: SWM.SWOP04071-03.003	Date Analysis Commenced	: 12-Dec-2022
C-O-C number	: CORD MCKENZIE TRAILS	Issue Date	: 16-Dec-2022 15:04
Sampler	: Ryan Miller		
Site	: ----		
Quote number	: CG22-EBAE100-0021 City of Red Deer (CORD) Pre-1972 Landfill Sites		
No. of samples received	: 4		
No. of samples analysed	: 4		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Anthony Calero	Supervisor - Inorganic	Inorganics, Calgary, Alberta
Jeanie Mark	Laboratory Analyst	Organics, Calgary, Alberta
Kevin Baxter	Team Leader - Inorganics	Metals, Calgary, Alberta
Shirley Li	Team Leader - Inorganics	Inorganics, Calgary, Alberta
Shirley Li	Team Leader - Inorganics	Metals, Calgary, Alberta
Sonthuong Bui	Laboratory Analyst	Metals, Calgary, Alberta
Summie Lo	Lab Assistant	Metals, Calgary, Alberta
Vladka Stamenova	Analyst	Inorganics, Calgary, Alberta

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances

LOR: Limit of Reporting (detection limit).

Unit	*Description*
-	no units
%	percent
µg/L	micrograms per litre
µS/cm	microsiemens per centimetre
meq/L	milliequivalents per litre
mg/L	milligrams per litre
pH units	pH units

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Qualifiers

Qualifier	*Description*
DLDS	*Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.*

Analytical Results

Sub-Matrix: Water
(Matrix: Water)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	MW-03	MW-04	MW-203	DUPLICATE	----
					Client sampling date / time	08-Dec-2022 10:35	08-Dec-2022 10:45	08-Dec-2022 11:00	08-Dec-2022	----
						CG2217088-001	CG2217088-002	CG2217088-003	CG2217088-004	--------
						Result	Result	Result	Result	----
Physical Tests										
alkalinity, bicarbonate (as HCO3)	71-52-3	E290	1.0	mg/L		1140	1120	896	1140	----
alkalinity, carbonate (as CO3)	3812-32-6	E290	1.0	mg/L		<1.0	<1.0	<1.0	<1.0	----
alkalinity, hydroxide (as OH)	14280-30-9	E290	1.0	mg/L		<1.0	<1.0	<1.0	<1.0	----
alkalinity, total (as CaCO3)	----	E290	1.0	mg/L		934	920	735	937	----
conductivity	----	E100	1.0	µS/cm		1660	1610	1350	1650	----
hardness (as CaCO3), dissolved	----	EC100	0.50	mg/L		544	668	529	570	----
pH	----	E108	0.10	pH units		7.77	7.62	7.71	7.75	----
solids, total dissolved [TDS], calculated	----	EC103	1.0	mg/L		1080	1040	858	1100	----
Anions and Nutrients										
ammonia, total (as N)	7664-41-7	E298	0.0050	mg/L		5.57	11.0	14.1	5.52	----
chloride	16887-00-6	E235.Cl	0.50	mg/L		41.4	28.1	22.9	40.2	----
fluoride	16984-48-8	E235.F	0.020	mg/L		0.157	0.233	0.218	0.123	----
nitrate (as N)	14797-55-8	E235.NO3	0.020	mg/L		0.152	<0.100 DLDS	<0.100 DLDS	<0.100 DLDS	----
nitrate + nitrite (as N)	----	EC235.N+N	0.0032	mg/L		0.152	<0.112	<0.112	<0.112	----
nitrite (as N)	14797-65-0	E235.NO2	0.010	mg/L		<0.050 DLDS	<0.050 DLDS	<0.050 DLDS	<0.050 DLDS	----
sulfate (as SO4)	14808-79-8	E235.SO4	0.30	mg/L		69.6	64.8	85.3	69.2	----
Ion Balance										
anion sum	----	EC101	0.10	meq/L		21.3	20.5	17.1	21.3	----
cation sum	----	EC101	0.10	meq/L		19.8	19.6	15.5	20.4	----
ion balance (APHA)	----	EC101	0.01	%		-3.65	-2.24	-4.91	-2.16	----
ion balance (cations/anions)	----	EC101	0.010	%		93.0	95.6	90.6	95.8	----
Dissolved Metals										
aluminum, dissolved	7429-90-5	E421	0.0010	mg/L		0.0036	0.0036	0.0060	0.0039	----
antimony, dissolved	7440-36-0	E421	0.00010	mg/L		<0.00010	0.00012	<0.00010	<0.00010	----
arsenic, dissolved	7440-38-2	E421	0.00010	mg/L		0.00130	0.00398	0.00396	0.00120	----
barium, dissolved	7440-39-3	E421	0.00010	mg/L		0.360	0.277	0.243	0.366	----
boron, dissolved	7440-42-8	E421	0.010	mg/L		0.791	1.06	0.534	0.818	----
cadmium, dissolved	7440-43-9	E421	0.0000050	mg/L		0.0000830	0.0000098	<0.0000050	0.0000861	----
calcium, dissolved	7440-70-2	E421	0.050	mg/L		134	162	130	145	----

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	MW-03	MW-04	MW-203	DUPLICATE	----
					Client sampling date / time	08-Dec-2022 10:35	08-Dec-2022 10:45	08-Dec-2022 11:00	08-Dec-2022	----
						CG2217088-001	CG2217088-002	CG2217088-003	CG2217088-004	--------
						Result	Result	Result	Result	----
Dissolved Metals										
chromium, dissolved	7440-47-3	E421	0.00050	mg/L		<0.00050	<0.00050	<0.00050	<0.00050	----
copper, dissolved	7440-50-8	E421	0.00020	mg/L		0.00051	0.00134	<0.00020	0.00041	----
iron, dissolved	7439-89-6	E421	0.010	mg/L		0.029	3.70	0.753	0.029	----
lead, dissolved	7439-92-1	E421	0.000050	mg/L		<0.000050	<0.000050	<0.000050	<0.000050	----
magnesium, dissolved	7439-95-4	E421	0.0050	mg/L		50.8	64.0	49.7	50.4	----
manganese, dissolved	7439-96-5	E421	0.00010	mg/L		0.796	1.06	0.358	0.810	----
mercury, dissolved	7439-97-6	E509	0.0000050	mg/L		<0.0000050	<0.0000050	<0.0000050	<0.0000050	----
nickel, dissolved	7440-02-0	E421	0.00050	mg/L		0.00467	0.0112	0.00182	0.00466	----
potassium, dissolved	7440-09-7	E421	0.050	mg/L		8.49	19.3	13.7	8.80	----
selenium, dissolved	7782-49-2	E421	0.000050	mg/L		0.000063	0.000064	0.00360	0.000285	----
silver, dissolved	7440-22-4	E421	0.000010	mg/L		<0.000010	<0.000010	<0.000010	<0.000010	----
sodium, dissolved	7440-23-5	E421	0.050	mg/L		190	110	80.2	192	----
uranium, dissolved	7440-61-1	E421	0.000010	mg/L		0.00212	0.00291	0.000473	0.00234	----
zinc, dissolved	7440-66-6	E421	0.0010	mg/L		0.0021	0.0028	0.0019	0.0013	----
dissolved mercury filtration location	----	EP509	-	-		Field	Field	Field	Field	----
dissolved metals filtration location	----	EP421	-	-		Field	Field	Field	Field	----
Volatile Organic Compounds										
benzene	71-43-2	E611E	0.50	µg/L		<0.50	<0.50	0.79	<0.50	----
bromobenzene	108-86-1	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
bromochloromethane	74-97-5	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
bromodichloromethane	75-27-4	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
bromoform	75-25-2	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
bromomethane	74-83-9	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
butylbenzene, n-	104-51-8	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
butylbenzene, sec-	135-98-8	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
butylbenzene, tert-	98-06-6	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
carbon tetrachloride	56-23-5	E611E	0.50	µg/L		<0.50	<0.50	<0.50	<0.50	----
chlorobenzene	108-90-7	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
chloroethane	75-00-3	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
chloroform	67-66-3	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	MW-03	MW-04	MW-203	DUPLICATE	----
					Client sampling date / time	08-Dec-2022 10:35	08-Dec-2022 10:45	08-Dec-2022 11:00	08-Dec-2022	----
						CG2217088-001	CG2217088-002	CG2217088-003	CG2217088-004	--------
						Result	Result	Result	Result	----
Volatile Organic Compounds										
chloromethane	74-87-3	E611E	5.0	µg/L		<5.0	<5.0	<5.0	<5.0	----
chlorotoluene, 2-	95-49-8	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
chlorotoluene, 4-	106-43-4	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
cymene, p-	99-87-6	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dibromo-3-chloropropane, 1,2-	96-12-8	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dibromochloromethane	124-48-1	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dibromoethane, 1,2-	106-93-4	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dibromomethane	74-95-3	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichlorobenzene, 1,2-	95-50-1	E611E	0.50	µg/L		<0.50	<0.50	<0.50	<0.50	----
dichlorobenzene, 1,3-	541-73-1	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichlorobenzene, 1,4-	106-46-7	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichlorodifluoromethane	75-71-8	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichloroethane, 1,1-	75-34-3	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichloroethane, 1,2-	107-06-2	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichloroethylene, 1,1-	75-35-4	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichloroethylene, cis-1,2-	156-59-2	E611E	1.0	µg/L		4.9	10.2	10.6	5.3	----
dichloroethylene, trans-1,2-	156-60-5	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichloromethane	75-09-2	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichloropropane, 1,2-	78-87-5	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichloropropane, 1,3-	142-28-9	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichloropropane, 2,2-	594-20-7	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichloropropylene, 1,1-	563-58-6	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichloropropylene, cis+trans-1,3-	542-75-6	E611E	1.5	µg/L		<1.5	<1.5	<1.5	<1.5	----
dichloropropylene, cis-1,3-	10061-01-5	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
dichloropropylene, trans-1,3-	10061-02-6	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
ethylbenzene	100-41-4	E611E	0.50	µg/L		<0.50	<0.50	<0.50	<0.50	----
hexachlorobutadiene	87-68-3	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
isopropylbenzene	98-82-8	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	0.50	µg/L		<0.50	<0.50	<0.50	<0.50	----
propylbenzene, n-	103-65-1	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----

Analytical Results

Sub-Matrix: Water (Matrix: Water)					Client sample ID	MW-03	MW-04	MW-203	DUPLICATE	----
					Client sampling date / time	08-Dec-2022 10:35	08-Dec-2022 10:45	08-Dec-2022 11:00	08-Dec-2022	----
Analyte	CAS Number	Method	LOR	Unit		CG2217088-001	CG2217088-002	CG2217088-003	CG2217088-004	--------
						Result	Result	Result	Result	----
Volatile Organic Compounds										
styrene	100-42-5	E611E	0.50	µg/L		<0.50	<0.50	<0.50	<0.50	----
tetrachloroethane, 1,1,1,2-	630-20-6	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
tetrachloroethane, 1,1,2,2-	79-34-5	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
tetrachloroethylene	127-18-4	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
toluene	108-88-3	E611E	0.50	µg/L		<0.50	<0.50	<0.50	<0.50	----
trichlorobenzene, 1,2,3-	87-61-6	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
trichlorobenzene, 1,2,4-	120-82-1	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
trichloroethane, 1,1,1-	71-55-6	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
trichloroethane, 1,1,2-	79-00-5	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
trichloroethylene	79-01-6	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
trichlorofluoromethane	75-69-4	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
trichloropropane, 1,2,3-	96-18-4	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
trimethylbenzene, 1,2,4-	95-63-6	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
trimethylbenzene, 1,3,5-	108-67-8	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
vinyl chloride	75-01-4	E611E	1.0	µg/L		1.6	3.7	6.2	1.6	----
xylene, m+p-	179601-23-1	E611E	0.40	µg/L		<0.40	<0.40	<0.40	<0.40	----
xylene, o-	95-47-6	E611E	0.30	µg/L		<0.30	<0.30	<0.30	<0.30	----
xylenes, total	1330-20-7	E611E	0.50	µg/L		<0.50	<0.50	<0.50	<0.50	----
BTEX, total	----	E611E	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	----
trihalomethanes [THMs], total	----	E611E	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	----
Volatile Organic Compounds Surrogates										
bromofluorobenzene, 4-	460-00-4	E611E	1.0	%		77.5	75.8	77.2	72.1	----
difluorobenzene, 1,4-	540-36-3	E611E	1.0	%		101	102	101	101	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

ALS Canada Ltd.

right solutions.
right partner.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **CG2217088**	Page	: 1 of 12
Client	: **Tetra Tech Canada Inc.**	Laboratory	: Calgary - Environmental
Contact	: Darby Madalena	Account Manager	: Patryk Wojciak
Address	: 110, 140 Quarry Park Blvd SE Calgary AB Canada T2C 3G3	Address	: 2559 29th Street NE Calgary, Alberta Canada T1Y 7B5
Telephone	: 403 203 3355	Telephone	: +1 403 407 1800
Project	: SWM.SWOP04071-03.003	Date Samples Received	: 12-Dec-2022 08:00
PO	: SWM.SWOP04071-03.003	Issue Date	: 16-Dec-2022 15:05
C-O-C number	: CORD MCKENZIE TRAILS		
Sampler	: Ryan Miller		
Site	: ----		
Quote number	: CG22-EBAE100-0021 City of Red Deer (CORD) Pre-1972 Landfill Sites		
No. of samples received	: 4		
No. of samples analysed	: 4		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike outliers occur.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Anions and Nutrients : Ammonia by Fluorescence										
Amber glass total (sulfuric acid) DUPLICATE	E298	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Ammonia by Fluorescence										
Amber glass total (sulfuric acid) MW-03	E298	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Ammonia by Fluorescence										
Amber glass total (sulfuric acid) MW-04	E298	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Ammonia by Fluorescence										
Amber glass total (sulfuric acid) MW-203	E298	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Chloride in Water by IC										
HDPE DUPLICATE	E235.Cl	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Chloride in Water by IC										
HDPE MW-03	E235.Cl	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Chloride in Water by IC										
HDPE MW-04	E235.Cl	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Anions and Nutrients : Chloride in Water by IC										
HDPE										
MW-203	E235.Cl	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Fluoride in Water by IC										
HDPE										
DUPLICATE	E235.F	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Fluoride in Water by IC										
HDPE										
MW-03	E235.F	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Fluoride in Water by IC										
HDPE										
MW-04	E235.F	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Fluoride in Water by IC										
HDPE										
MW-203	E235.F	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE										
DUPLICATE	E235.NO3	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	3 days	4 days	× EHTR-FM
Anions and Nutrients : Nitrate in Water by IC										
HDPE										
MW-03	E235.NO3	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	3 days	4 days	× EHTR-FM
Anions and Nutrients : Nitrate in Water by IC										
HDPE										
MW-04	E235.NO3	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	3 days	4 days	× EHTR-FM
Anions and Nutrients : Nitrate in Water by IC										
HDPE										
MW-203	E235.NO3	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	3 days	4 days	× EHTR-FM

Matrix: **Water**

Evaluation: ✖ = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Anions and Nutrients : Nitrite in Water by IC										
HDPE DUPLICATE	E235.NO2	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	3 days	4 days	✖ EHTR-FM
Anions and Nutrients : Nitrite in Water by IC										
HDPE MW-03	E235.NO2	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	3 days	4 days	✖ EHTR-FM
Anions and Nutrients : Nitrite in Water by IC										
HDPE MW-04	E235.NO2	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	3 days	4 days	✖ EHTR-FM
Anions and Nutrients : Nitrite in Water by IC										
HDPE MW-203	E235.NO2	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	3 days	4 days	✖ EHTR-FM
Anions and Nutrients : Sulfate in Water by IC										
HDPE DUPLICATE	E235.SO4	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE MW-03	E235.SO4	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE MW-04	E235.SO4	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE MW-203	E235.SO4	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Dissolved Metals : Dissolved Mercury in Water by CVAAS										
Glass vial dissolved (hydrochloric acid) DUPLICATE	E509	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Dissolved Metals : Dissolved Mercury in Water by CVAAS										
Glass vial dissolved (hydrochloric acid) MW-03	E509	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Dissolved Metals : Dissolved Mercury in Water by CVAAS										
Glass vial dissolved (hydrochloric acid) MW-04	E509	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Dissolved Metals : Dissolved Mercury in Water by CVAAS										
Glass vial dissolved (hydrochloric acid) MW-203	E509	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	28 days	4 days	✓
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE dissolved (nitric acid) DUPLICATE	E421	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	180 days	6 days	✓
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE dissolved (nitric acid) MW-03	E421	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	180 days	6 days	✓
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE dissolved (nitric acid) MW-04	E421	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	180 days	6 days	✓
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE dissolved (nitric acid) MW-203	E421	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	180 days	6 days	✓
Physical Tests : Alkalinity Species by Titration										
HDPE DUPLICATE	E290	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	14 days	6 days	✓
Physical Tests : Alkalinity Species by Titration										
HDPE MW-03	E290	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	14 days	6 days	✓

Matrix: **Water**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : Alkalinity Species by Titration										
HDPE MW-04	E290	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	14 days	6 days	✓
Physical Tests : Alkalinity Species by Titration										
HDPE MW-203	E290	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	14 days	6 days	✓
Physical Tests : Conductivity in Water										
HDPE DUPLICATE	E100	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	28 days	6 days	✓
Physical Tests : Conductivity in Water										
HDPE MW-03	E100	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	28 days	6 days	✓
Physical Tests : Conductivity in Water										
HDPE MW-04	E100	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	28 days	6 days	✓
Physical Tests : Conductivity in Water										
HDPE MW-203	E100	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	28 days	6 days	✓
Physical Tests : pH by Meter										
HDPE DUPLICATE	E108	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	0.25 hrs	0.25 hrs	× EHTR-FM
Physical Tests : pH by Meter										
HDPE MW-03	E108	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	0.25 hrs	0.25 hrs	× EHTR-FM
Physical Tests : pH by Meter										
HDPE MW-04	E108	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	0.25 hrs	0.25 hrs	× EHTR-FM

Matrix: **Water**

Evaluation: ✖ = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : pH by Meter										
HDPE										
MW-203	E108	08-Dec-2022	14-Dec-2022	----	----		14-Dec-2022	0.25 hrs	0.25 hrs	✖ EHTR-FM
Volatile Organic Compounds : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate)										
DUPLICATE	E611E	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	14 days	4 days	✓
Volatile Organic Compounds : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate)										
MW-03	E611E	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	14 days	4 days	✓
Volatile Organic Compounds : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate)										
MW-04	E611E	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	14 days	4 days	✓
Volatile Organic Compounds : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate)										
MW-203	E611E	08-Dec-2022	12-Dec-2022	----	----		12-Dec-2022	14 days	4 days	✓

Legend & Qualifier Definitions

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Water**

Evaluation: × = QC frequency outside specification; ✓ = QC frequency within specification.

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Alkalinity Species by Titration	E290	778186	1	18	5.5	5.0	✓
Ammonia by Fluorescence	E298	775577	1	8	12.5	5.0	✓
Chloride in Water by IC	E235.Cl	775886	1	11	9.0	5.0	✓
Conductivity in Water	E100	778188	1	18	5.5	5.0	✓
Dissolved Mercury in Water by CVAAS	E509	775718	1	14	7.1	5.0	✓
Dissolved Metals in Water by CRC ICPMS	E421	777979	1	18	5.5	5.0	✓
Fluoride in Water by IC	E235.F	775883	1	11	9.0	5.0	✓
Nitrate in Water by IC	E235.NO3	775884	1	11	9.0	5.0	✓
Nitrite in Water by IC	E235.NO2	775885	1	11	9.0	5.0	✓
pH by Meter	E108	778187	1	18	5.5	5.0	✓
Sulfate in Water by IC	E235.SO4	775887	1	11	9.0	5.0	✓
VOCs (Prairies List) by Headspace GC-MS	E611E	775458	1	8	12.5	5.0	✓
Laboratory Control Samples (LCS)							
Alkalinity Species by Titration	E290	778186	1	18	5.5	5.0	✓
Ammonia by Fluorescence	E298	775577	1	8	12.5	5.0	✓
Chloride in Water by IC	E235.Cl	775886	1	11	9.0	5.0	✓
Conductivity in Water	E100	778188	1	18	5.5	5.0	✓
Dissolved Mercury in Water by CVAAS	E509	775718	1	14	7.1	5.0	✓
Dissolved Metals in Water by CRC ICPMS	E421	777979	1	18	5.5	5.0	✓
Fluoride in Water by IC	E235.F	775883	1	11	9.0	5.0	✓
Nitrate in Water by IC	E235.NO3	775884	1	11	9.0	5.0	✓
Nitrite in Water by IC	E235.NO2	775885	1	11	9.0	5.0	✓
pH by Meter	E108	778187	1	18	5.5	5.0	✓
Sulfate in Water by IC	E235.SO4	775887	1	11	9.0	5.0	✓
VOCs (Prairies List) by Headspace GC-MS	E611E	775458	1	8	12.5	5.0	✓
Method Blanks (MB)							
Alkalinity Species by Titration	E290	778186	1	18	5.5	5.0	✓
Ammonia by Fluorescence	E298	775577	1	8	12.5	5.0	✓
Chloride in Water by IC	E235.Cl	775886	1	11	9.0	5.0	✓
Conductivity in Water	E100	778188	1	18	5.5	5.0	✓
Dissolved Mercury in Water by CVAAS	E509	775718	1	14	7.1	5.0	✓
Dissolved Metals in Water by CRC ICPMS	E421	777979	1	18	5.5	5.0	✓
Fluoride in Water by IC	E235.F	775883	1	11	9.0	5.0	✓
Nitrate in Water by IC	E235.NO3	775884	1	11	9.0	5.0	✓
Nitrite in Water by IC	E235.NO2	775885	1	11	9.0	5.0	✓

Matrix: **Water**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Method Blanks (MB) - Continued							
Sulfate in Water by IC	E235.SO4	775887	1	11	9.0	5.0	✓
VOCs (Prairies List) by Headspace GC-MS	E611E	775458	1	8	12.5	5.0	✓
Matrix Spikes (MS)							
Ammonia by Fluorescence	E298	775577	1	8	12.5	5.0	✓
Chloride in Water by IC	E235.Cl	775886	1	11	9.0	5.0	✓
Dissolved Mercury in Water by CVAAS	E509	775718	1	14	7.1	5.0	✓
Dissolved Metals in Water by CRC ICPMS	E421	777979	1	18	5.5	5.0	✓
Fluoride in Water by IC	E235.F	775883	1	11	9.0	5.0	✓
Nitrate in Water by IC	E235.NO3	775884	1	11	9.0	5.0	✓
Nitrite in Water by IC	E235.NO2	775885	1	11	9.0	5.0	✓
Sulfate in Water by IC	E235.SO4	775887	1	11	9.0	5.0	✓
VOCs (Prairies List) by Headspace GC-MS	E611E	775458	1	8	12.5	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Conductivity in Water	E100 Calgary - Environmental	Water	APHA 2510 (mod)	Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a water sample. Conductivity measurements are temperature-compensated to 25°C.
pH by Meter	E108 Calgary - Environmental	Water	APHA 4500-H (mod)	pH is determined by potentiometric measurement with a pH electrode, and is conducted at ambient laboratory temperature (normally 20 ± 5°C). For high accuracy test results, pH should be measured in the field within the recommended 15 minute hold time.
Chloride in Water by IC	E235.Cl Calgary - Environmental	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Fluoride in Water by IC	E235.F Calgary - Environmental	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Nitrite in Water by IC	E235.NO2 Calgary - Environmental	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Nitrate in Water by IC	E235.NO3 Calgary - Environmental	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Sulfate in Water by IC	E235.SO4 Calgary - Environmental	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Alkalinity Species by Titration	E290 Calgary - Environmental	Water	APHA 2320 B (mod)	Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.
Ammonia by Fluorescence	E298 Calgary - Environmental	Water	Method Fialab 100, 2018	Ammonia in water is determined by automated continuous flow analysis with membrane diffusion and fluorescence detection, after reaction with OPA (ortho-phthalaldehyde). This method is approved under US EPA 40 CFR Part 136 (May 2021)
Dissolved Metals in Water by CRC ICPMS	E421 Calgary - Environmental	Water	APHA 3030B/EPA 6020B (mod)	Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by Collision/Reaction Cell ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.
Dissolved Mercury in Water by CVAAS	E509 Calgary - Environmental	Water	APHA 3030B/EPA 1631E (mod)	Water samples are filtered (0.45 um), preserved with HCl, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS.
VOCs (Prairies List) by Headspace GC-MS	E611E Calgary - Environmental	Water	EPA 8260D (mod)	Volatile Organic Compounds (VOCs) are analyzed by static headspace GC-MS. Samples are prepared in headspace vials and are heated and agitated on the headspace autosampler, causing VOCs to partition between the aqueous phase and the headspace in accordance with Henry's law.

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Dissolved Hardness (Calculated)	EC100 Calgary - Environmental	Water	APHA 2340B	"Hardness (as CaCO3), dissolved" is calculated from the sum of dissolved Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. "Total Hardness" refers to the sum of Calcium and Magnesium Hardness. Hardness is normally or preferentially calculated from dissolved Calcium and Magnesium concentrations, because it is a property of water due to dissolved divalent cations.
Ion Balance using Dissolved Metals	EC101 Calgary - Environmental	Water	APHA 1030E	Cation Sum, Anion Sum, and Ion Balance are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Dissolved species are used where available. Minor ions are included where data is present. Ion Balance cannot be calculated accurately for waters with very low electrical conductivity (EC).
TDS in Water (Calculation)	EC103 Calgary - Environmental	Water	APHA 1030E (mod)	Total Dissolved Solids is calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Dissolved species are used where available. Minor ions are included where data is present.
Nitrate and Nitrite (as N) (Calculation)	EC235.N+N Calgary - Environmental	Water	EPA 300.0	Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Preparation for Ammonia	EP298 Calgary - Environmental	Water		Sample preparation for Preserved Nutrients Water Quality Analysis.
Dissolved Metals Water Filtration	EP421 Calgary - Environmental	Water	APHA 3030B	Water samples are filtered (0.45 um), and preserved with HNO3.
Dissolved Mercury Water Filtration	EP509 Calgary - Environmental	Water	APHA 3030B	Water samples are filtered (0.45 um), and preserved with HCl.
VOCs Preparation for Headspace Analysis	EP581 Calgary - Environmental	Water	EPA 5021A (mod)	Samples are prepared in headspace vials and are heated and agitated on the headspace autosampler. An aliquot of the headspace is then injected into the GC/MS-FID system.

ALS Canada Ltd.

right solutions.
right partner.

QUALITY CONTROL REPORT

Work Order	: **CG2217088**	Page	: 1 of 15
Client	: Tetra Tech Canada Inc.	Laboratory	: Calgary - Environmental
Contact	: Darby Madalena	Account Manager	: Patryk Wojciak
Address	: 110, 140 Quarry Park Blvd SE Calgary AB Canada T2C 3G3	Address	: 2559 29th Street NE Calgary, Alberta Canada T1Y 7B5
Telephone	:	Telephone	: +1 403 407 1800
Project	: SWM.SWOP04071-03.003	Date Samples Received	: 12-Dec-2022 08:00
PO	: SWM.SWOP04071-03.003	Date Analysis Commenced	: 12-Dec-2022
C-O-C number	: CORD MCKENZIE TRAILS	Issue Date	: 16-Dec-2022 15:05
Sampler	: Ryan Miller 403 203 3355		
Site	: ----		
Quote number	: CG22-EBAE100-0021 City of Red Deer (CORD) Pre-1972 Landfill Sites		
No. of samples received	: 4		
No. of samples analysed	: 4		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Matrix Spike (MS) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Anthony Calero	Supervisor - Inorganic	Calgary Inorganics, Calgary, Alberta
Jeanie Mark	Laboratory Analyst	Calgary Organics, Calgary, Alberta
Kevin Baxter	Team Leader - Inorganics	Calgary Metals, Calgary, Alberta
Shirley Li	Team Leader - Inorganics	Calgary Inorganics, Calgary, Alberta
Shirley Li	Team Leader - Inorganics	Calgary Metals, Calgary, Alberta
Sonthuong Bui	Laboratory Analyst	Calgary Metals, Calgary, Alberta
Summie Lo	Lab Assistant	Calgary Metals, Calgary, Alberta
Vladka Stamenova	Analyst	Calgary Inorganics, Calgary, Alberta

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percent Difference
# = Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Physical Tests (QC Lot: 778186)											
CG2217087-004	Anonymous	alkalinity, total (as CaCO3)	----	E290	1.0	mg/L	770	759	1.48%	20%	----
Physical Tests (QC Lot: 778187)											
CG2217087-004	Anonymous	pH	----	E108	0.10	pH units	7.19	7.25	0.831%	4%	----
Physical Tests (QC Lot: 778188)											
CG2217087-004	Anonymous	conductivity	----	E100	1.0	µS/cm	2470	2490	0.806%	10%	----
Anions and Nutrients (QC Lot: 775577)											
CG2217087-001	Anonymous	ammonia, total (as N)	7664-41-7	E298	0.125	mg/L	2.82	2.85	1.13%	20%	----
Anions and Nutrients (QC Lot: 775883)											
CG2217087-001	Anonymous	fluoride	16984-48-8	E235.F	0.100	mg/L	0.253	0.250	0.003	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 775884)											
CG2217087-001	Anonymous	nitrate (as N)	14797-55-8	E235.NO3	0.100	mg/L	<0.100	<0.100	0	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 775885)											
CG2217087-001	Anonymous	nitrite (as N)	14797-65-0	E235.NO2	0.050	mg/L	<0.050	<0.050	0	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 775886)											
CG2217087-001	Anonymous	chloride	16887-00-6	E235.Cl	2.50	mg/L	381	387	1.56%	20%	----
Anions and Nutrients (QC Lot: 775887)											
CG2217087-001	Anonymous	sulfate (as SO4)	14808-79-8	E235.SO4	1.50	mg/L	118	119	1.35%	20%	----
Dissolved Metals (QC Lot: 775718)											
CG2216879-008	Anonymous	mercury, dissolved	7439-97-6	E509	0.0000050	mg/L	<0.0000050	<0.0000050	0	Diff <2x LOR	----
Dissolved Metals (QC Lot: 777979)											
CG2217056-009	Anonymous	aluminum, dissolved	7429-90-5	E421	0.0020	mg/L	0.0023	0.0041	0.0018	Diff <2x LOR	----
		antimony, dissolved	7440-36-0	E421	0.00020	mg/L	0.00023	<0.00020	0.00003	Diff <2x LOR	----
		arsenic, dissolved	7440-38-2	E421	0.00020	mg/L	0.00049	0.00060	0.00011	Diff <2x LOR	----
		barium, dissolved	7440-39-3	E421	0.00020	mg/L	0.00874	0.00956	8.96%	20%	----
		boron, dissolved	7440-42-8	E421	0.020	mg/L	0.038	0.038	0.0008	Diff <2x LOR	----
		cadmium, dissolved	7440-43-9	E421	0.0000100	mg/L	0.352 µg/L	0.000314	11.3%	20%	----
		calcium, dissolved	7440-70-2	E421	0.100	mg/L	270	271	0.568%	20%	----
		chromium, dissolved	7440-47-3	E421	0.00050	mg/L	<0.00050	<0.00050	0	Diff <2x LOR	----
		copper, dissolved	7440-50-8	E421	0.00040	mg/L	<0.00040	<0.00040	0	Diff <2x LOR	----
		iron, dissolved	7439-89-6	E421	0.020	mg/L	0.021	0.020	0.00007	Diff <2x LOR	----

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Dissolved Metals (QC Lot: 777979) - continued											
CG2217056-009	Anonymous	lead, dissolved	7439-92-1	E421	0.000100	mg/L	<0.000100	<0.000100	0	Diff <2x LOR	----
		magnesium, dissolved	7439-95-4	E421	0.0100	mg/L	143	151	5.47%	20%	----
		manganese, dissolved	7439-96-5	E421	0.00020	mg/L	0.420	0.447	6.14%	20%	----
		nickel, dissolved	7440-02-0	E421	0.00100	mg/L	0.0612	0.0651	6.22%	20%	----
		potassium, dissolved	7440-09-7	E421	0.100	mg/L	4.83	5.16	6.66%	20%	----
		selenium, dissolved	7782-49-2	E421	0.000100	mg/L	1.80 µg/L	0.00185	2.37%	20%	----
		silver, dissolved	7440-22-4	E421	0.000020	mg/L	<0.000020	<0.000020	0	Diff <2x LOR	----
		sodium, dissolved	7440-23-5	E421	0.100	mg/L	10.5	10.9	4.27%	20%	----
		uranium, dissolved	7440-61-1	E421	0.000020	mg/L	0.00966	0.00982	1.70%	20%	----
		zinc, dissolved	7440-66-6	E421	0.0020	mg/L	0.0238	0.0244	2.38%	20%	----
Volatile Organic Compounds (QC Lot: 775458)											
CG2217087-001	Anonymous	benzene	71-43-2	E611E	0.50	µg/L	1.16	1.27	0.11	Diff <2x LOR	----
		bromobenzene	108-86-1	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		bromochloromethane	74-97-5	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		bromodichloromethane	75-27-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		bromoform	75-25-2	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		bromomethane	74-83-9	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		butylbenzene, n-	104-51-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		butylbenzene, sec-	135-98-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		butylbenzene, tert-	98-06-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		carbon tetrachloride	56-23-5	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		chlorobenzene	108-90-7	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		chloroethane	75-00-3	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		chloroform	67-66-3	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		chloromethane	74-87-3	E611E	5.0	µg/L	<5.0	<5.0	0	Diff <2x LOR	----
		chlorotoluene, 2-	95-49-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		chlorotoluene, 4-	106-43-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		cymene, p-	99-87-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dibromo-3-chloropropane, 1,2-	96-12-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dibromochloromethane	124-48-1	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dibromoethane, 1,2-	106-93-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dibromomethane	74-95-3	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichlorobenzene, 1,2-	95-50-1	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		dichlorobenzene, 1,3-	541-73-1	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Volatile Organic Compounds (QC Lot: 775458) - continued											
CG2217087-001	Anonymous	dichlorobenzene, 1,4-	106-46-7	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichlorodifluoromethane	75-71-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichloroethane, 1,1-	75-34-3	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichloroethane, 1,2-	107-06-2	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichloroethylene, 1,1-	75-35-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichloroethylene, cis-1,2-	156-59-2	E611E	1.0	µg/L	14.7	15.9	7.87%	30%	----
		dichloroethylene, trans-1,2-	156-60-5	E611E	1.0	µg/L	2.3	2.7	0.3	Diff <2x LOR	----
		dichloromethane	75-09-2	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichloropropane, 1,2-	78-87-5	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichloropropane, 1,3-	142-28-9	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichloropropane, 2,2-	594-20-7	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichloropropylene, 1,1-	563-58-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichloropropylene, cis-1,3-	10061-01-5	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		dichloropropylene, trans-1,3-	10061-02-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		ethylbenzene	100-41-4	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		hexachlorobutadiene	87-68-3	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		isopropylbenzene	98-82-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		propylbenzene, n-	103-65-1	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		styrene	100-42-5	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		tetrachloroethane, 1,1,1,2-	630-20-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		tetrachloroethane, 1,1,2,2-	79-34-5	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		tetrachloroethylene	127-18-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		toluene	108-88-3	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		trichlorobenzene, 1,2,3-	87-61-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		trichlorobenzene, 1,2,4-	120-82-1	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		trichloroethane, 1,1,1-	71-55-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		trichloroethane, 1,1,2-	79-00-5	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		trichloroethylene	79-01-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		trichlorofluoromethane	75-69-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		trichloropropane, 1,2,3-	96-18-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		trimethylbenzene, 1,2,4-	95-63-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		trimethylbenzene, 1,3,5-	108-67-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		vinyl chloride	75-01-4	E611E	1.0	µg/L	8.7	9.4	8.09%	50%	----

Sub-Matrix: **Water**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Volatile Organic Compounds (QC Lot: 775458) - continued											
CG2217087-001	Anonymous	xylene, m+p-	179601-23-1	E611E	0.40	µg/L	<0.40	<0.40	0	Diff <2x LOR	----
		xylene, o-	95-47-6	E611E	0.30	µg/L	<0.30	<0.30	0	Diff <2x LOR	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Physical Tests (QCLot: 778186)						
alkalinity, total (as CaCO3)	----	E290	1	mg/L	<1.0	----
Physical Tests (QCLot: 778188)						
conductivity	----	E100	1	µS/cm	<1.0	----
Anions and Nutrients (QCLot: 775577)						
ammonia, total (as N)	7664-41-7	E298	0.005	mg/L	<0.0050	----
Anions and Nutrients (QCLot: 775883)						
fluoride	16984-48-8	E235.F	0.02	mg/L	<0.020	----
Anions and Nutrients (QCLot: 775884)						
nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	<0.020	----
Anions and Nutrients (QCLot: 775885)						
nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	<0.010	----
Anions and Nutrients (QCLot: 775886)						
chloride	16887-00-6	E235.Cl	0.5	mg/L	<0.50	----
Anions and Nutrients (QCLot: 775887)						
sulfate (as SO4)	14808-79-8	E235.SO4	0.3	mg/L	<0.30	----
Dissolved Metals (QCLot: 775718)						
mercury, dissolved	7439-97-6	E509	0.000005	mg/L	<0.0000050	----
Dissolved Metals (QCLot: 777979)						
aluminum, dissolved	7429-90-5	E421	0.001	mg/L	<0.0010	----
antimony, dissolved	7440-36-0	E421	0.0001	mg/L	<0.00010	----
arsenic, dissolved	7440-38-2	E421	0.0001	mg/L	<0.00010	----
barium, dissolved	7440-39-3	E421	0.0001	mg/L	<0.00010	----
boron, dissolved	7440-42-8	E421	0.01	mg/L	<0.010	----
cadmium, dissolved	7440-43-9	E421	0.000005	mg/L	<0.0000050	----
calcium, dissolved	7440-70-2	E421	0.05	mg/L	<0.050	----
chromium, dissolved	7440-47-3	E421	0.0005	mg/L	<0.00050	----
copper, dissolved	7440-50-8	E421	0.0002	mg/L	<0.00020	----
iron, dissolved	7439-89-6	E421	0.01	mg/L	<0.010	----
lead, dissolved	7439-92-1	E421	0.00005	mg/L	<0.000050	----
magnesium, dissolved	7439-95-4	E421	0.005	mg/L	<0.0050	----
manganese, dissolved	7439-96-5	E421	0.0001	mg/L	<0.00010	----
nickel, dissolved	7440-02-0	E421	0.0005	mg/L	<0.00050	----

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Dissolved Metals (QCLot: 777979) - continued						
potassium, dissolved	7440-09-7	E421	0.05	mg/L	<0.050	----
selenium, dissolved	7782-49-2	E421	0.00005	mg/L	<0.000050	----
silver, dissolved	7440-22-4	E421	0.00001	mg/L	<0.000010	----
sodium, dissolved	7440-23-5	E421	0.05	mg/L	<0.050	----
uranium, dissolved	7440-61-1	E421	0.00001	mg/L	<0.000010	----
zinc, dissolved	7440-66-6	E421	0.001	mg/L	<0.0010	----
Volatile Organic Compounds (QCLot: 775458)						
benzene	71-43-2	E611E	0.5	µg/L	<0.50	----
bromobenzene	108-86-1	E611E	1	µg/L	<1.0	----
bromochloromethane	74-97-5	E611E	1	µg/L	<1.0	----
bromodichloromethane	75-27-4	E611E	1	µg/L	<1.0	----
bromoform	75-25-2	E611E	1	µg/L	<1.0	----
bromomethane	74-83-9	E611E	1	µg/L	<1.0	----
butylbenzene, n-	104-51-8	E611E	1	µg/L	<1.0	----
butylbenzene, sec-	135-98-8	E611E	1	µg/L	<1.0	----
butylbenzene, tert-	98-06-6	E611E	1	µg/L	<1.0	----
carbon tetrachloride	56-23-5	E611E	0.5	µg/L	<0.50	----
chlorobenzene	108-90-7	E611E	1	µg/L	<1.0	----
chloroethane	75-00-3	E611E	1	µg/L	<1.0	----
chloroform	67-66-3	E611E	1	µg/L	<1.0	----
chloromethane	74-87-3	E611E	5	µg/L	<5.0	----
chlorotoluene, 2-	95-49-8	E611E	1	µg/L	<1.0	----
chlorotoluene, 4-	106-43-4	E611E	1	µg/L	<1.0	----
cymene, p-	99-87-6	E611E	1	µg/L	<1.0	----
dibromo-3-chloropropane, 1,2-	96-12-8	E611E	1	µg/L	<1.0	----
dibromochloromethane	124-48-1	E611E	1	µg/L	<1.0	----
dibromoethane, 1,2-	106-93-4	E611E	1	µg/L	<1.0	----
dibromomethane	74-95-3	E611E	1	µg/L	<1.0	----
dichlorobenzene, 1,2-	95-50-1	E611E	0.5	µg/L	<0.50	----
dichlorobenzene, 1,3-	541-73-1	E611E	1	µg/L	<1.0	----
dichlorobenzene, 1,4-	106-46-7	E611E	1	µg/L	<1.0	----
dichlorodifluoromethane	75-71-8	E611E	1	µg/L	<1.0	----
dichloroethane, 1,1-	75-34-3	E611E	1	µg/L	<1.0	----
dichloroethane, 1,2-	107-06-2	E611E	1	µg/L	<1.0	----
dichloroethylene, 1,1-	75-35-4	E611E	1	µg/L	<1.0	----

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Volatile Organic Compounds (QCLot: 775458) - continued						
dichloroethylene, cis-1,2-	156-59-2	E611E	1	µg/L	<1.0	----
dichloroethylene, trans-1,2-	156-60-5	E611E	1	µg/L	<1.0	----
dichloromethane	75-09-2	E611E	1	µg/L	<1.0	----
dichloropropane, 1,2-	78-87-5	E611E	1	µg/L	<1.0	----
dichloropropane, 1,3-	142-28-9	E611E	1	µg/L	<1.0	----
dichloropropane, 2,2-	594-20-7	E611E	1	µg/L	<1.0	----
dichloropropylene, 1,1-	563-58-6	E611E	1	µg/L	<1.0	----
dichloropropylene, cis-1,3-	10061-01-5	E611E	1	µg/L	<1.0	----
dichloropropylene, trans-1,3-	10061-02-6	E611E	1	µg/L	<1.0	----
ethylbenzene	100-41-4	E611E	0.5	µg/L	<0.50	----
hexachlorobutadiene	87-68-3	E611E	1	µg/L	<1.0	----
isopropylbenzene	98-82-8	E611E	1	µg/L	<1.0	----
methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	0.5	µg/L	<0.50	----
propylbenzene, n-	103-65-1	E611E	1	µg/L	<1.0	----
styrene	100-42-5	E611E	0.5	µg/L	<0.50	----
tetrachloroethane, 1,1,1,2-	630-20-6	E611E	1	µg/L	<1.0	----
tetrachloroethane, 1,1,2,2-	79-34-5	E611E	1	µg/L	<1.0	----
tetrachloroethylene	127-18-4	E611E	1	µg/L	<1.0	----
toluene	108-88-3	E611E	0.5	µg/L	<0.50	----
trichlorobenzene, 1,2,3-	87-61-6	E611E	1	µg/L	<1.0	----
trichlorobenzene, 1,2,4-	120-82-1	E611E	1	µg/L	<1.0	----
trichloroethane, 1,1,1-	71-55-6	E611E	1	µg/L	<1.0	----
trichloroethane, 1,1,2-	79-00-5	E611E	1	µg/L	<1.0	----
trichloroethylene	79-01-6	E611E	1	µg/L	<1.0	----
trichlorofluoromethane	75-69-4	E611E	1	µg/L	<1.0	----
trichloropropane, 1,2,3-	96-18-4	E611E	1	µg/L	<1.0	----
trimethylbenzene, 1,2,4-	95-63-6	E611E	1	µg/L	<1.0	----
trimethylbenzene, 1,3,5-	108-67-8	E611E	1	µg/L	<1.0	----
vinyl chloride	75-01-4	E611E	1	µg/L	<1.0	----
xylene, m+p-	179601-23-1	E611E	0.4	µg/L	<0.40	----
xylene, o-	95-47-6	E611E	0.3	µg/L	<0.30	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Water**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Physical Tests (QCLot: 778186)									
alkalinity, total (as CaCO3)	----	E290	1	mg/L	500 mg/L	112	85.0	115	----
Physical Tests (QCLot: 778187)									
pH	----	E108	----	pH units	7 pH units	101	98.6	101	----
Physical Tests (QCLot: 778188)									
conductivity	----	E100	1	µS/cm	146.9 µS/cm	100	90.0	110	----
Anions and Nutrients (QCLot: 775577)									
ammonia, total (as N)	7664-41-7	E298	0.005	mg/L	0.2 mg/L	96.6	85.0	115	----
Anions and Nutrients (QCLot: 775883)									
fluoride	16984-48-8	E235.F	0.02	mg/L	1 mg/L	100	90.0	110	----
Anions and Nutrients (QCLot: 775884)									
nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	2.5 mg/L	98.6	90.0	110	----
Anions and Nutrients (QCLot: 775885)									
nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	0.5 mg/L	98.1	90.0	110	----
Anions and Nutrients (QCLot: 775886)									
chloride	16887-00-6	E235.Cl	0.5	mg/L	100 mg/L	99.6	90.0	110	----
Anions and Nutrients (QCLot: 775887)									
sulfate (as SO4)	14808-79-8	E235.SO4	0.3	mg/L	100 mg/L	101	90.0	110	----
mercury, dissolved	7439-97-6	E509	0.000005	mg/L	0.0001 mg/L	108	80.0	120	----
Dissolved Metals (QCLot: 777979)									
aluminum, dissolved	7429-90-5	E421	0.001	mg/L	2 mg/L	98.0	80.0	120	----
antimony, dissolved	7440-36-0	E421	0.0001	mg/L	1 mg/L	83.7	80.0	120	----
arsenic, dissolved	7440-38-2	E421	0.0001	mg/L	1 mg/L	97.6	80.0	120	----
barium, dissolved	7440-39-3	E421	0.0001	mg/L	0.25 mg/L	86.0	80.0	120	----
boron, dissolved	7440-42-8	E421	0.01	mg/L	1 mg/L	86.0	80.0	120	----
cadmium, dissolved	7440-43-9	E421	0.000005	mg/L	0.1 mg/L	97.8	80.0	120	----
calcium, dissolved	7440-70-2	E421	0.05	mg/L	50 mg/L	98.2	80.0	120	----
chromium, dissolved	7440-47-3	E421	0.0005	mg/L	0.25 mg/L	98.9	80.0	120	----
copper, dissolved	7440-50-8	E421	0.0002	mg/L	0.25 mg/L	97.5	80.0	120	----
iron, dissolved	7439-89-6	E421	0.01	mg/L	1 mg/L	84.0	80.0	120	----
lead, dissolved	7439-92-1	E421	0.00005	mg/L	0.5 mg/L	83.3	80.0	120	----

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Laboratory Control Sample (LCS) Report: Spike Concentration	Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High	Qualifier
Dissolved Metals (QCLot: 777979) - continued									
magnesium, dissolved	7439-95-4	E421	0.005	mg/L	50 mg/L	92.7	80.0	120	----
manganese, dissolved	7439-96-5	E421	0.0001	mg/L	0.25 mg/L	98.0	80.0	120	----
nickel, dissolved	7440-02-0	E421	0.0005	mg/L	0.5 mg/L	97.2	80.0	120	----
potassium, dissolved	7440-09-7	E421	0.05	mg/L	50 mg/L	99.0	80.0	120	----
selenium, dissolved	7782-49-2	E421	0.00005	mg/L	1 mg/L	94.3	80.0	120	----
silver, dissolved	7440-22-4	E421	0.00001	mg/L	0.1 mg/L	81.4	80.0	120	----
sodium, dissolved	7440-23-5	E421	0.05	mg/L	50 mg/L	99.9	80.0	120	----
uranium, dissolved	7440-61-1	E421	0.00001	mg/L	0.005 mg/L	96.6	80.0	120	----
zinc, dissolved	7440-66-6	E421	0.001	mg/L	0.5 mg/L	95.1	80.0	120	----
Volatile Organic Compounds (QCLot: 775458)									
benzene	71-43-2	E611E	0.5	µg/L	100 µg/L	106	70.0	130	----
bromobenzene	108-86-1	E611E	1	µg/L	100 µg/L	120	70.0	130	----
bromochloromethane	74-97-5	E611E	1	µg/L	100 µg/L	107	70.0	130	----
bromodichloromethane	75-27-4	E611E	1	µg/L	100 µg/L	105	70.0	130	----
bromoform	75-25-2	E611E	1	µg/L	100 µg/L	111	70.0	130	----
bromomethane	74-83-9	E611E	1	µg/L	100 µg/L	106	60.0	140	----
butylbenzene, n-	104-51-8	E611E	1	µg/L	100 µg/L	80.8	70.0	130	----
butylbenzene, sec-	135-98-8	E611E	1	µg/L	100 µg/L	116	70.0	130	----
butylbenzene, tert-	98-06-6	E611E	1	µg/L	100 µg/L	122	70.0	130	----
carbon tetrachloride	56-23-5	E611E	0.5	µg/L	100 µg/L	123	70.0	130	----
chlorobenzene	108-90-7	E611E	1	µg/L	100 µg/L	105	70.0	130	----
chloroethane	75-00-3	E611E	1	µg/L	100 µg/L	128	60.0	140	----
chloroform	67-66-3	E611E	1	µg/L	100 µg/L	111	70.0	130	----
chloromethane	74-87-3	E611E	5	µg/L	100 µg/L	116	60.0	140	----
chlorotoluene, 2-	95-49-8	E611E	1	µg/L	100 µg/L	116	70.0	130	----
chlorotoluene, 4-	106-43-4	E611E	1	µg/L	100 µg/L	118	70.0	130	----
cymene, p-	99-87-6	E611E	1	µg/L	100 µg/L	98.2	70.0	130	----
dibromo-3-chloropropane, 1,2-	96-12-8	E611E	1	µg/L	100 µg/L	93.9	70.0	130	----
dibromochloromethane	124-48-1	E611E	1	µg/L	100 µg/L	113	70.0	130	----
dibromoethane, 1,2-	106-93-4	E611E	1	µg/L	100 µg/L	99.4	70.0	130	----
dibromomethane	74-95-3	E611E	1	µg/L	100 µg/L	105	70.0	130	----
dichlorobenzene, 1,2-	95-50-1	E611E	0.5	µg/L	100 µg/L	108	70.0	130	----
dichlorobenzene, 1,3-	541-73-1	E611E	1	µg/L	100 µg/L	108	70.0	130	----
dichlorobenzene, 1,4-	106-46-7	E611E	1	µg/L	100 µg/L	108	70.0	130	----
dichlorodifluoromethane	75-71-8	E611E	1	µg/L	100 µg/L	118	60.0	140	----

Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
					Concentration	LCS	Low	High	Qualifier
Volatile Organic Compounds (QCLot: 775458) - continued									
dichloroethane, 1,1-	75-34-3	E611E	1	µg/L	100 µg/L	118	70.0	130	----
dichloroethane, 1,2-	107-06-2	E611E	1	µg/L	100 µg/L	104	70.0	130	----
dichloroethylene, 1,1-	75-35-4	E611E	1	µg/L	100 µg/L	122	70.0	130	----
dichloroethylene, cis-1,2-	156-59-2	E611E	1	µg/L	100 µg/L	106	70.0	130	----
dichloroethylene, trans-1,2-	156-60-5	E611E	1	µg/L	100 µg/L	104	70.0	130	----
dichloromethane	75-09-2	E611E	1	µg/L	100 µg/L	111	70.0	130	----
dichloropropane, 1,2-	78-87-5	E611E	1	µg/L	100 µg/L	106	70.0	130	----
dichloropropane, 1,3-	142-28-9	E611E	1	µg/L	100 µg/L	106	70.0	130	----
dichloropropane, 2,2-	594-20-7	E611E	1	µg/L	100 µg/L	93.9	70.0	130	----
dichloropropylene, 1,1-	563-58-6	E611E	1	µg/L	100 µg/L	102	70.0	130	----
dichloropropylene, cis-1,3-	10061-01-5	E611E	1	µg/L	100 µg/L	88.6	70.0	130	----
dichloropropylene, trans-1,3-	10061-02-6	E611E	1	µg/L	100 µg/L	75.8	70.0	130	----
ethylbenzene	100-41-4	E611E	0.5	µg/L	100 µg/L	95.0	70.0	130	----
hexachlorobutadiene	87-68-3	E611E	1	µg/L	100 µg/L	75.5	70.0	130	----
isopropylbenzene	98-82-8	E611E	1	µg/L	100 µg/L	108	70.0	130	----
methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	0.5	µg/L	100 µg/L	111	70.0	130	----
propylbenzene, n-	103-65-1	E611E	1	µg/L	100 µg/L	88.6	70.0	130	----
styrene	100-42-5	E611E	0.5	µg/L	100 µg/L	88.1	70.0	130	----
tetrachloroethane, 1,1,1,2-	630-20-6	E611E	1	µg/L	100 µg/L	97.9	70.0	130	----
tetrachloroethane, 1,1,2,2-	79-34-5	E611E	1	µg/L	100 µg/L	127	70.0	130	----
tetrachloroethylene	127-18-4	E611E	1	µg/L	100 µg/L	102	70.0	130	----
toluene	108-88-3	E611E	0.5	µg/L	100 µg/L	102	70.0	130	----
trichlorobenzene, 1,2,3-	87-61-6	E611E	1	µg/L	100 µg/L	83.2	70.0	130	----
trichlorobenzene, 1,2,4-	120-82-1	E611E	1	µg/L	100 µg/L	80.0	70.0	130	----
trichloroethane, 1,1,1-	71-55-6	E611E	1	µg/L	100 µg/L	127	70.0	130	----
trichloroethane, 1,1,2-	79-00-5	E611E	1	µg/L	100 µg/L	112	70.0	130	----
trichloroethylene	79-01-6	E611E	1	µg/L	100 µg/L	104	70.0	130	----
trichlorofluoromethane	75-69-4	E611E	1	µg/L	100 µg/L	121	60.0	140	----
trichloropropane, 1,2,3-	96-18-4	E611E	1	µg/L	100 µg/L	122	70.0	130	----
trimethylbenzene, 1,2,4-	95-63-6	E611E	1	µg/L	100 µg/L	102	70.0	130	----
trimethylbenzene, 1,3,5-	108-67-8	E611E	1	µg/L	100 µg/L	117	70.0	130	----
vinyl chloride	75-01-4	E611E	1	µg/L	100 µg/L	114	60.0	140	----
xylene, m+p-	179601-23-1	E611E	0.4	µg/L	200 µg/L	110	70.0	130	----
xylene, o-	95-47-6	E611E	0.3	µg/L	100 µg/L	93.9	70.0	130	----

Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND – Recovery not determined, background level >= 1x spike level.

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Anions and Nutrients (QCLot: 775577)										
CG2217087-002	Anonymous	ammonia, total (as N)	7664-41-7	E298	ND mg/L	0.1 mg/L	ND	75.0	125	----
Anions and Nutrients (QCLot: 775883)										
CG2217087-002	Anonymous	fluoride	16984-48-8	E235.F	0.911 mg/L	1 mg/L	91.1	75.0	125	----
Anions and Nutrients (QCLot: 775884)										
CG2217087-002	Anonymous	nitrate (as N)	14797-55-8	E235.NO3	2.42 mg/L	2.5 mg/L	96.9	75.0	125	----
Anions and Nutrients (QCLot: 775885)										
CG2217087-002	Anonymous	nitrite (as N)	14797-65-0	E235.NO2	0.497 mg/L	0.5 mg/L	99.4	75.0	125	----
Anions and Nutrients (QCLot: 775886)										
CG2217087-002	Anonymous	chloride	16887-00-6	E235.Cl	ND mg/L	100 mg/L	ND	75.0	125	----
Anions and Nutrients (QCLot: 775887)										
CG2217087-002	Anonymous	sulfate (as SO4)	14808-79-8	E235.SO4	ND mg/L	100 mg/L	ND	75.0	125	----
Dissolved Metals (QCLot: 775718)										
CG2216972-012	Anonymous	mercury, dissolved	7439-97-6	E509	0.000108 mg/L	0.0001 mg/L	108	70.0	130	----
Dissolved Metals (QCLot: 777979)										
CG2217056-010	Anonymous	aluminum, dissolved	7429-90-5	E421	2.15 mg/L	2 mg/L	108	70.0	130	----
		antimony, dissolved	7440-36-0	E421	0.170 mg/L	0.2 mg/L	84.9	70.0	130	----
		arsenic, dissolved	7440-38-2	E421	0.222 mg/L	0.2 mg/L	111	70.0	130	----
		barium, dissolved	7440-39-3	E421	0.173 mg/L	0.2 mg/L	86.7	70.0	130	----
		boron, dissolved	7440-42-8	E421	1.02 mg/L	1 mg/L	102	70.0	130	----
		cadmium, dissolved	7440-43-9	E421	0.0449 mg/L	0.04 mg/L	112	70.0	130	----
		calcium, dissolved	7440-70-2	E421	ND mg/L	40 mg/L	ND	70.0	130	----
		chromium, dissolved	7440-47-3	E421	0.461 mg/L	0.4 mg/L	115	70.0	130	----
		copper, dissolved	7440-50-8	E421	0.223 mg/L	0.2 mg/L	112	70.0	130	----
		iron, dissolved	7439-89-6	E421	18.0 mg/L	20 mg/L	89.8	70.0	130	----
		lead, dissolved	7439-92-1	E421	0.173 mg/L	0.2 mg/L	86.7	70.0	130	----
		magnesium, dissolved	7439-95-4	E421	ND mg/L	10 mg/L	ND	70.0	130	----
		manganese, dissolved	7439-96-5	E421	ND mg/L	0.2 mg/L	ND	70.0	130	----
		nickel, dissolved	7440-02-0	E421	0.449 mg/L	0.4 mg/L	112	70.0	130	----
		potassium, dissolved	7440-09-7	E421	44.4 mg/L	40 mg/L	111	70.0	130	----

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Dissolved Metals (QCLot: 777979) - continued										
CG2217056-010	Anonymous	selenium, dissolved	7782-49-2	E421	0.462 mg/L	0.4 mg/L	116	70.0	130	----
		silver, dissolved	7440-22-4	E421	0.0367 mg/L	0.04 mg/L	91.8	70.0	130	----
		sodium, dissolved	7440-23-5	E421	21.9 mg/L	20 mg/L	109	70.0	130	----
		uranium, dissolved	7440-61-1	E421	0.0350 mg/L	0.04 mg/L	87.5	70.0	130	----
		zinc, dissolved	7440-66-6	E421	4.46 mg/L	4 mg/L	112	70.0	130	----
Volatile Organic Compounds (QCLot: 775458)										
CG2217087-001	Anonymous	benzene	71-43-2	E611E	94.9 µg/L	100 µg/L	94.9	70.0	130	----
		bromobenzene	108-86-1	E611E	128 µg/L	100 µg/L	128	70.0	130	----
		bromochloromethane	74-97-5	E611E	88.8 µg/L	100 µg/L	88.8	70.0	130	----
		bromodichloromethane	75-27-4	E611E	90.2 µg/L	100 µg/L	90.2	70.0	130	----
		bromoform	75-25-2	E611E	110 µg/L	100 µg/L	110	70.0	130	----
		bromomethane	74-83-9	E611E	93.6 µg/L	100 µg/L	93.6	60.0	140	----
		butylbenzene, n-	104-51-8	E611E	84.3 µg/L	100 µg/L	84.3	70.0	130	----
		butylbenzene, sec-	135-98-8	E611E	128 µg/L	100 µg/L	128	70.0	130	----
		butylbenzene, tert-	98-06-6	E611E	128 µg/L	100 µg/L	128	70.0	130	----
		carbon tetrachloride	56-23-5	E611E	114 µg/L	100 µg/L	114	70.0	130	----
		chlorobenzene	108-90-7	E611E	109 µg/L	100 µg/L	109	70.0	130	----
		chloroethane	75-00-3	E611E	117 µg/L	100 µg/L	117	60.0	140	----
		chloroform	67-66-3	E611E	99.2 µg/L	100 µg/L	99.2	70.0	130	----
		chloromethane	74-87-3	E611E	104 µg/L	100 µg/L	104	60.0	140	----
		chlorotoluene, 2-	95-49-8	E611E	128 µg/L	100 µg/L	128	70.0	130	----
		chlorotoluene, 4-	106-43-4	E611E	130 µg/L	100 µg/L	130	70.0	130	----
		cymene, p-	99-87-6	E611E	107 µg/L	100 µg/L	107	70.0	130	----
		dibromo-3-chloropropane, 1,2-	96-12-8	E611E	76.3 µg/L	100 µg/L	76.3	70.0	130	----
		dibromochloromethane	124-48-1	E611E	109 µg/L	100 µg/L	109	70.0	130	----
		dibromoethane, 1,2-	106-93-4	E611E	92.4 µg/L	100 µg/L	92.4	70.0	130	----
		dibromomethane	74-95-3	E611E	84.1 µg/L	100 µg/L	84.1	70.0	130	----
		dichlorobenzene, 1,2-	95-50-1	E611E	111 µg/L	100 µg/L	111	70.0	130	----
		dichlorobenzene, 1,3-	541-73-1	E611E	119 µg/L	100 µg/L	119	70.0	130	----
		dichlorobenzene, 1,4-	106-46-7	E611E	115 µg/L	100 µg/L	115	70.0	130	----
		dichlorodifluoromethane	75-71-8	E611E	123 µg/L	100 µg/L	123	60.0	140	----
		dichloroethane, 1,1-	75-34-3	E611E	105 µg/L	100 µg/L	105	70.0	130	----
		dichloroethane, 1,2-	107-06-2	E611E	85.5 µg/L	100 µg/L	85.5	70.0	130	----
		dichloroethylene, 1,1-	75-35-4	E611E	112 µg/L	100 µg/L	112	70.0	130	----
		dichloroethylene, cis-1,2-	156-59-2	E611E	88.7 µg/L	100 µg/L	88.7	70.0	130	----

Sub-Matrix: **Water**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Volatile Organic Compounds (QCLot: 775458) - continued										
CG2217087-001	Anonymous	dichloroethylene, trans-1,2-	156-60-5	E611E	96.0 µg/L	100 µg/L	96.0	70.0	130	----
		dichloromethane	75-09-2	E611E	93.0 µg/L	100 µg/L	93.0	70.0	130	----
		dichloropropane, 1,2-	78-87-5	E611E	91.7 µg/L	100 µg/L	91.7	70.0	130	----
		dichloropropane, 1,3-	142-28-9	E611E	100 µg/L	100 µg/L	100	70.0	130	----
		dichloropropane, 2,2-	594-20-7	E611E	81.2 µg/L	100 µg/L	81.2	70.0	130	----
		dichloropropylene, 1,1-	563-58-6	E611E	95.7 µg/L	100 µg/L	95.7	70.0	130	----
		dichloropropylene, cis-1,3-	10061-01-5	E611E	80.0 µg/L	100 µg/L	80.0	70.0	130	----
		dichloropropylene, trans-1,3-	10061-02-6	E611E	71.8 µg/L	100 µg/L	71.8	70.0	130	----
		ethylbenzene	100-41-4	E611E	95.8 µg/L	100 µg/L	95.8	70.0	130	----
		hexachlorobutadiene	87-68-3	E611E	71.9 µg/L	100 µg/L	71.9	70.0	130	----
		isopropylbenzene	98-82-8	E611E	112 µg/L	100 µg/L	112	70.0	130	----
		methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	115 µg/L	100 µg/L	115	70.0	130	----
		propylbenzene, n-	103-65-1	E611E	91.5 µg/L	100 µg/L	91.5	70.0	130	----
		styrene	100-42-5	E611E	83.5 µg/L	100 µg/L	83.5	70.0	130	----
		tetrachloroethane, 1,1,1,2-	630-20-6	E611E	104 µg/L	100 µg/L	104	70.0	130	----
		tetrachloroethane, 1,1,2,2-	79-34-5	E611E	112 µg/L	100 µg/L	112	70.0	130	----
		tetrachloroethylene	127-18-4	E611E	112 µg/L	100 µg/L	112	70.0	130	----
		toluene	108-88-3	E611E	104 µg/L	100 µg/L	104	70.0	130	----
		trichlorobenzene, 1,2,3-	87-61-6	E611E	79.8 µg/L	100 µg/L	79.8	70.0	130	----
		trichlorobenzene, 1,2,4-	120-82-1	E611E	83.0 µg/L	100 µg/L	83.0	70.0	130	----
		trichloroethane, 1,1,1-	71-55-6	E611E	117 µg/L	100 µg/L	117	70.0	130	----
		trichloroethane, 1,1,2-	79-00-5	E611E	106 µg/L	100 µg/L	106	70.0	130	----
		trichloroethylene	79-01-6	E611E	95.8 µg/L	100 µg/L	95.8	70.0	130	----
		trichlorofluoromethane	75-69-4	E611E	109 µg/L	100 µg/L	109	60.0	140	----
		trichloropropane, 1,2,3-	96-18-4	E611E	111 µg/L	100 µg/L	111	70.0	130	----
		trimethylbenzene, 1,2,4-	95-63-6	E611E	109 µg/L	100 µg/L	109	70.0	130	----
		trimethylbenzene, 1,3,5-	108-67-8	E611E	123 µg/L	100 µg/L	123	70.0	130	----
		vinyl chloride	75-01-4	E611E	105 µg/L	100 µg/L	105	60.0	140	----
		xylene, m+p-	179601-23-1	E611E	221 µg/L	200 µg/L	110	70.0	130	----
		xylene, o-	95-47-6	E611E	95.6 µg/L	100 µg/L	95.6	70.0	130	----

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # CORD McKenzie Trails

Page 1 of 1

Report to:			Report Format / Distribution	Service Requested:
Company:	Tetra Tech Canada Inc.		☐ Standard ☐ Other	☑ Regular Service (Default)
Contact:	Darby Madalena		☑ PDF ☑ Excel ☐ Fax	☐ Rush Service (2-3 Days)
Address:	110, 140 Quarry Park Blvd SE, Calgary, AB T2C 3G3		Email 1: darby.madalena@tetratech.com	☐ Priority Service (1 Day or ASAP)
			Email 2: ryan.miller@tetratech.com	☐ Emergency Service (<1 Day / Wkend) - Contact ALS
Phone:	403-723-6867	Fax: 403-203-3301	ALS Digital Crosstab results	Analysis Request
Invoice To:	☑ Same as Report		Indicate Bottles: Filtered / Preserved (F/P) →→	
Company:	SAME AS REPORT		**Client / Project Information:**	
Contact:			Job #: SWM.SWOP04071-03.003	
Address:			PO/AFE: SWM.SWOP04071-03.003	
Sample			Legal Site Description:	
Phone:		Fax:	Quote #: CG22-EBAE100-C	
Lab Work Order # (lab use only)			ALS Contact: Patryk Wojciak	Sampler (Initials): Ryan Miller

Sample #	Sample Identification (This description will appear on the report)	Date dd-mmm-yy	Time hh:mm	Sample Type (Select from drop-down list)	E611E (VOCs)	S5421B - Routine & Dissolved	E298 - Ammonia	Hazardous?	Highly Contaminated?	Number of Containers
	MW-03	08-12-22	10:35	Water	X	X	X			6
	MW-04	↓	10:45	Water	X	X	X			6
	MW-203		11:00	Water	X	X	X			6
	Duplicate	↓	-	Water	X	X	X			6

Guidelines / Regulations	Special Instructions / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

Relinquished By:	Ryan Miller	Date & Time:	Dec 11/22	Received By:	YL	Date & Time:	12/12 8:00	Sample Condition (lab use)	
Relinquished By:		Date & Time:	15:15	Received By:		Date & Time:		Temperature 5C	Samples Received in Good Condition? Y / N (if not provided details)

Environmental Division
Calgary
Work Order Reference
CG2217088

Telephone : +1 403 407 1800

APPENDIX E

HISTORICAL ANALYTICAL DATA

Table 4A
Groundwater Indices Measured at Time of Sampling

Monitoring Well	pH	Electrical Conductivity (µg/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Total Dissolved Solid (mg/L)	Redox (±mV)
MW-01	7.50	449.5	12.9	0.58	379.60	-121.2
MW-02	7.59	423.3	13.7	3.87	347.75	-21.9
MW-03	7.97	1,078	7.9	3.24	1,040.00	-133.4
MW-04	- -	- -	- -	- -	- -	- -
MW-05	7.22	1,585	9.7	3.53	1,438.50	-139.3

Notes:

1) Measurement of groundwater indices by YSI Pro Plus.
2) Groundwater sampled on Monday, August 19, 2013.

Table 4B
Analytical Results - Groundwater - General Water Quality

Parameter	Unit	Detection Limit	MW-01	MW-02	MW-03	MW-05	Tier 1 Guideline
			08/19/2013				
General Water Quality							
Biochemical Oxygen Demand (BOD)	mg/L	2	14	3.8	ND	38	- -
Chemical Oxygen Demand (COD)	mg/L	5.0 - 25	150	32	47	200	- -
Conductivity	µS/cm	1	590	560	1,700	2,200	- -
pH	Unitless	N/A	7.88	7.82	8.07	7.89	6.5-8.5
Total Organic Carbon (C)	mg/L	0.50 - 2.5	15	13	21	38	- -
Dissolved Cadmium (Cd)	µg/L	0.005	0.012	NT	0.037	0.097	- -
Total Cadmium (Cd)	µg/L	0.005	**0.73**	**0.33**	**0.98**	**0.79**	0.060*
Alkalinity (Total as $CaCO_3$)	mg/L	0.5	280	260	800	740	- -
Bicarbonate (HCO_3)	mg/L	0.5	340	320	980	910	- -
Carbonate (CO_3)	mg/L	0.5	ND	ND	ND	ND	- -
Hydroxide (OH)	mg/L	0.5	ND	ND	ND	ND	- -
Sulphate (SO_4)	mg/L	1.0 - 5.0	17	27	32	450	- -
Chloride (Cl)	mg/L	1	9.3	7.2	70	62	- -
Total Ammonia (N)	mg/L	0.050 - 0.50	0.47	ND	**6.3**	**30**	1.37*
Total Phosphorus (P)	mg/L	0.0030 - 0.030	1.5	0.068	0.38	2.1	- -
Total Nitrogen (N)	mg/L	0.05	2.1	0.58	6.9	35	- -
Total Kjeldahl Nitrogen	mg/L	0.050 - 1.3	2.1	0.57	6.9	35	- -
Nitrite (as N)	mg/L	0.003	ND	ND	0.010	0.018	- -
Nitrate (as N)	mg/L	0.003	0.015	0.0079	0.017	0.054	- -
Nitrate plus Nitrite (N)	mg/L	0.0003	0.015	0.0080	0.027	0.072	- -
Trace Organics							
Acetic Acid	mg/L	50	ND	NT	ND	ND	- -
Formic Acid	mg/L	50	ND	NT	ND	ND	- -
Propionic Acid	mg/L	50	ND	NT	ND	ND	- -
Adsorbable Organic halogens	mg/L	0.02	0.03	NT	0.07	0.04	- -

Notes:

1) Tier 1 Guideline - Alberta Tier 1 Soil and Groundwater Remediation Guidelines, December 2010 and amendments. Coarse-grained criteria for residential/parkland land use.
2) * Surface Water Quality Guidelines for Use in Alberta (AENV, 1999) on aquatic life pathway. Canadian Council of Ministers of the Environment (CCME) guidelines are referenced.
3) ND - Not Detected, less than the limit of method detection.
4) NT - Not Tested
5) - - No value established in the reference criteria.
6) Bold & Shaded - Exceeds the referenced Alberta Tier 1 Guidelines and CCME guidelines.
7) For further laboratory information, refer to the specific laboratory report in Appendix A.

Table 4C
Analytical Results - Groundwater - Metals

Parameter	Detection Limit	MW-01	MW-02	MW-03	MW-05	Tier 1 Guideline
		08/19/2013				
Total Metals						
Aluminum (Al)	0.0030	**10**	**0.73**	**7.9**	**0.37**	0.1*
Antimony (Sb)	0.00060	0.00063	ND	ND	0.0017	0.006
Arsenic (As)	0.00020	**0.015**	0.0011	**0.0071**	**0.0089**	0.005
Barium (Ba)	0.010	0.72	0.015	0.5	0.37	1
Beryllium (Be)	0.0010	ND	ND	ND	ND	- -
Boron (B)	0.020	0.041	0.022	0.43	**1.8**	1.5
Calcium (Ca)	0.30	120	78	150	240	- -
Chromium (Cr)	0.0010	**0.018**	**0.0035**	**0.014**	**0.003**	0.001*
Cobalt (Co)	0.00030	0.011	0.00087	0.008	0.012	- -
Copper (Cu)	0.00020	**0.042**	**0.0043**	**0.023**	**0.026**	0.003*
Iron (Fe)	0.060	**25**	**1.6**	**19**	**22**	0.3
Lead (Pb)	0.00020	**0.019**	0.0017	**0.012**	**0.11**	0.004*
Lithium (Li)	0.020	0.025	ND	0.075	0.031	- -
Magnesium (Mg)	0.20	46	22	40	91	- -
Manganese (Mn)	0.0040	**1.4**	**0.1**	**0.9**	**0.6**	0.05
Molybdenum (Mo)	0.00020	0.004	0.0025	0.0017	0.0021	- -
Nickel (Ni)	0.00050	0.0340	0.0035	0.025	0.012	0.11*
Phosphorus (P)	0.10	1.10	ND	1.2	0.94	- -
Potassium (K)	0.30	6.8	3.5	6.2	45	- -
Selenium (Se)	0.00020	0.00074	ND	0.00076	0.0004	0.001
Silicon (Si)	0.10	22	5.6	20	8.4	- -
Silver (Ag)	0.00010	**0.0002**	ND	**0.00022**	ND	0.0001*
Sodium (Na)	0.50	45	20	310	110	- -
Strontium (Sr)	0.020	0.45	0.38	1.1	1.3	- -
Sulphur (S)	0.20	5.1	7.8	15	130	- -
Thallium (Tl)	0.00020	ND	ND	ND	ND	- -
Tin (Sn)	0.0010	0.0015	0.003	0.0021	0.0065	- -
Titanium (Ti)	0.0010	0.14	0.025	0.0174	0.007	- -
Uranium (U)	0.00010	0.0018	0.0012	0.0022	0.0017	0.02
Vanadium (V)	0.0010	0.03	0.0024	0.021	0.0015	- -
Zinc (Zn)	0.0030	**0.11**	**0.078**	**0.25**	**0.12**	0.03
Dissolved Metals						
Aluminum (Al)	0.0030	0.0067	NT	0.040	0.0052	- -
Antimony (Sb)	0.00060	ND	NT	ND	0.00076	- -
Arsenic (As)	0.00020	0.0062	NT	0.0021	0.0079	- -
Barium (Ba)	0.010	0.28	NT	0.42	0.33	- -
Beryllium (Be)	0.0010	ND	NT	ND	ND	- -
Boron (B)	0.020	0.044	NT	0.64	1.9	- -
Calcium (Ca)	0.30	49	NT	110	230	- -
Chromium (Cr)	0.0010	ND	NT	ND	ND	- -
Cobalt (Co)	0.00030	0.00066	NT	0.0013	0.0048	- -
Copper (Cu)	0.00020	0.00027	NT	0.00098	0.00044	- -
Iron (Fe)	0.060	3	NT	0.52	17	- -
Lead (Pb)	0.00020	ND	NT	ND	0.00027	- -
Lithium (Li)	0.020	ND	NT	0.062	0.03	- -
Magnesium (Mg)	0.20	24	NT	34	92	- -
Manganese (Mn)	0.0040	0.84	NT	0.63	0.67	- -
Molybdenum (Mo)	0.00020	0.0042	NT	0.0025	0.00088	- -
Nickel (Ni)	0.00050	0.0014	NT	0.0032	0.0042	- -
Phosphorus (P)	0.10	ND	NT	0.16	ND	- -
Potassium (K)	0.30	4.5	NT	7.0	40	- -
Selenium (Se)	0.00020	0.00047	NT	ND	0.0002	- -
Silicon (Si)	0.10	5	NT	6	8	- -
Silver (Ag)	0.00010	ND	NT	ND	ND	- -
Sodium (Na)	0.50 - 2.5	43	NT	280	120	- -
Strontium (Sr)	0.020	0.34	NT	1.3	1.40	- -
Sulphur (S)	0.20 -1.0	4.5	NT	17	150	- -
Thallium (Tl)	0.00020	ND	NT	ND	ND	- -
Tin (Sn)	0.0010	ND	NT	ND	0.0018	- -
Titanium (Ti)	0.0010	ND	NT	ND	ND	- -
Uranium (U)	0.00010	0.00048	NT	0.0024	0.00085	- -
Vanadium (V)	0.0010	ND	NT	0.0011	ND	- -
Zinc (Zn)	0.0030	ND	NT	ND	0.02	- -

Notes:

1) Tier 1 Guideline - Alberta Tier 1 Soil and Groundwater Remediation Guidelines, December 2010 and amendments. Coarse-grained criteria for residential/parkland land use.
2) * Surface Water Quality Guidelines for Use in Alberta (AENV, 1999) on aquatic life pathway. Canadian Council of Ministers of the Environment (CCME) guidelines are referenced.
3) ND - Not Detected, less than the limit of method detection.
4) NT - Not Tested.
5) Unless specified all units are mg/L.
6) - - No value established in the reference criteria.
7) Bold & Shaded - Exceeds the referenced Alberta Tier 1 and CCME guidelines.
8) For further laboratory information, refer to the specific laboratory report in Appendix A.

Table 4D
Analytical Results - Groundwater -VOCs

Parameter	Detection Limit	MW-01	MW-02	MW-03	MW-05	Tier 1 Guideline
		08/19/2013				
Volatile Organic Compounds						
Benzene	0.00040	ND	ND	ND	0.0014	0.005
Toluene	0.00040	ND	ND	0.0011	0.00063	0.024
Ethylbenzene	0.00040	ND	ND	ND	ND	0.0024
Xylenes (Total)	0.00080	ND	ND	ND	ND	0.3
F1 (C_6-C_{10})	0.10	ND	ND	ND	ND	0.81
F2 (C_{10}-C_{16})	0.10	ND	ND	ND	ND	1.1
Total Trihalomethanes	0.0020	ND	ND	ND	ND	0.1
Bromodichloromethane	0.00050	ND	ND	ND	ND	- -
Bromoform	0.00050	ND	ND	ND	ND	- -
Bromomethane	0.0020	ND	ND	ND	ND	- -
Carbon tetrachloride	0.00050	ND	ND	ND	ND	0.00056
Chlorobenzene	0.00050	ND	ND	ND	ND	0.0013
Chlorodibromomethane	0.0010	ND	ND	ND	ND	- -
Chloroethane	0.0010	ND	ND	ND	ND	- -
Chloroform	0.00050	ND	ND	ND	ND	0.0018
Chloromethane	0.0020	ND	ND	ND	ND	- -
1,2-dibromoethane	0.00050	ND	ND	ND	ND	- -
1,2-dichlorobenzene	0.00050	ND	ND	ND	ND	0.0007
1,3-dichlorobenzene	0.00050	ND	ND	ND	ND	- -
1,4-dichlorobenzene	0.00050	ND	ND	ND	ND	0.001
1,1-dichloroethane	0.00050	ND	ND	ND	ND	- -
1,2-dichloroethane	0.00050	ND	ND	ND	ND	0.005
1,1-dichloroethene	0.00050	ND	ND	ND	ND	0.014
cis-1,2-dichloroethene	0.00050	ND	ND	0.0012	0.0037	- -
trans-1,2-dichloroethene	0.00050	ND	ND	ND	ND	- -
Dichloromethane	0.0020	ND	ND	ND	ND	0.05
1,2-dichloropropane	0.00050	ND	ND	ND	ND	- -
cis-1,3-dichloropropene	0.00050	ND	ND	ND	ND	- -
trans-1,3-dichloropropene	0.00050	ND	ND	ND	ND	- -
Methyl methacrylate	0.00050	ND	ND	ND	ND	0.47
Methyl-tert-butylether (MTBE)	0.00050	ND	ND	ND	ND	0.015
Styrene	0.00050	ND	ND	ND	ND	0.072
1,1,1,2-tetrachloroethane	0.0020	ND	ND	ND	ND	- -
1,1,2,2-tetrachloroethane	0.0020	ND	ND	ND	ND	- -
Tetrachloroethene	0.00050	ND	ND	ND	0.0033	0.03
1,2,3-trichlorobenzene	0.0010	ND	ND	ND	ND	0.008
1,2,4-trichlorobenzene	0.0010	ND	ND	ND	ND	0.015
1,3,5-trichlorobenzene	0.00050	ND	ND	ND	ND	0.014
1,1,1-trichloroethane	0.00050	ND	ND	ND	ND	- -
1,1,2-trichloroethane	0.00050	ND	ND	ND	ND	- -
Trichloroethene	0.00050	ND	ND	ND	ND	0.005
Trichlorofluoromethane	0.00050	ND	ND	ND	ND	- -
1,2,4-trimethylbenzene	0.00050	ND	ND	ND	ND	- -
1,3,5-trimethylbenzene	0.00050	ND	ND	ND	ND	- -
Vinyl chloride	0.00050	ND	ND	ND	0.0007	0.0011

Notes:

1) Tier 1 Guideline - Alberta Tier 1 Soil and Groundwater Remediation Guidelines, December 2010 and amendments. Coarse-grained criteria for residential/parkland land use.
2) ND - Not Detected, less than the limit of method detection.
3) Unless specified all units are mg/L
4) - - No value established in the reference criteria.
5) Bold & Shaded - Exceeds the referenced Alberta Tier 1 Guidelines.
6) For further laboratory information, refer to the specific laboratory report in Appendix A.

Table 5A
Summary of Monitoring Parameters During Sampling of Soil Vapour

Parameter Unit	Well Diameter (mm)	Well Depth (m)	Headspace Volume (cm^3)	Purge Rate (cm^3/min)	Purge Time (min)	Pressure	
						Ambient (psi)	Vapour Well (psi)
VW-01	25	5.5	2,700.0	943.3	5	15.00	15.00

Notes:

1) Measurement of pressure by digital Cole-Parmer absolute pressure gauge.
2) Purge time is elapsed time prior to the collection of a soil vapour sample.
3) Soil Vapour sampling was completed on August 19, 2013.

Table 5B
Analytical Results - Soil Vapour - General Indices

Parameter	Unit	Detection Limit	VW-01
Gauge Pressure			
Following sampling	psi	- -	
Reported by laboratory	psi	- -	(-4.0)
Fixed Gases			
Oxygen	% v/v	0.2	5.8
Nitrogen	% v/v	0.2	84.7
Carbon monoxide	% v/v	0.2	ND
Methane	% v/v	0.2	ND
Carbon dioxide	% v/v	0.2	9.5

Notes:

1) Soil vapour sample collected on Saturday, August 17, 2013.
2) ND - Not Detected, less than the limit of method detection.
3) - - No value established in the detection limit and reference criteria.
4) For further information, the reader should refer to the laboratory report in Appendix A.

Table 5C
Analytical Results - Soil Vapour - VOCs

Parameter	Unit	Detection Limit	VW-01
			08/17/2013
Hydrocarbon Fractions			
Aliphatic >C_5-C_6	µg/m^3	5.0	6.3
Aliphatic >C_6-C_8	µg/m^3	5.0	37.4
Aliphatic >C_8-C_{10}	µg/m^3	5.0	36.9
Aliphatic >C_{10}-C_{12}	µg/m^3	5.0	55.2
Aliphatic >C_{12}-C_{16}	µg/m^3	5.0	18.4
Aromatic >C_7-C_8 (TEX Excluded)	µg/m^3	5.0	ND
Aromatic >C_8-C_{10}	µg/m^3	5.0	10.2
Aromatic >C_{10}-C_{12}	µg/m^3	5.0	10.0
Aromatic >C_{12}-C_{16}	µg/m^3	5.0	ND
Select Volatile Gases			
Acetylene	ppm	0.2	ND
Ethane	ppm	0.2	ND
Ethylene	ppm	0.2	ND
Methane	ppm	4.1	ND
n-Butane	ppm	0.41	ND
n-Pentane	ppm	0.2	ND
Propane	ppm	0.2	ND
Propene	ppm	0.2	ND
Propyne	ppm	0.41	ND
Volatile Organic Compounds			
Dichlorodifluoromethane (FREON 12)	ppbv	0.20	0.74
1,2-Dichlorotetrafluoroethane	ppbv	0.17	ND
Chloromethane	ppbv	0.30	0.92
Vinyl chloride	ppbv	0.18	ND
Chloroethane	ppbv	0.30	ND
1,3-Butadiene	ppbv	0.50	ND
Trichlorofluoromethane (FREON 11)	ppbv	0.20	0.31
Ethanol (ethyl alcohol)	ppbv	2.3	104
Trichlorotrifluoroethane	ppbv	0.15	0.18
2-propanol	ppbv	3.0	ND
2-Propanone	ppbv	0.80	26
Methyl ethyl ketone (MEK) (2-Butanone)	ppbv	3.0	ND
Methyl isobutyl ketone	ppbv	3.2	ND
Methyl butyl ketone (MBK) (2-Hexanone)	ppbv	2.0	ND
Methyl t-butyl ether (MTBE)	ppbv	0.20	ND
Ethyl acetate	ppbv	2.2	ND
1,1-Dichloroethylene	ppbv	0.25	ND
cis-1,2-Dichloroethylene	ppbv	0.19	ND
trans-1,2-Dichloroethylene	ppbv	0.20	ND
Methylene chloride(Dichloromethane)	ppbv	0.80	ND
Chloroform	ppbv	0.15	0.24
Carbon tetrachloride	ppbv	0.30	ND
1,1-Dichloroethane	ppbv	0.20	ND
1,2-Dichloroethane	ppbv	0.20	ND
Ethylene dibromide	ppbv	0.17	ND
1,1,1-Trichloroethane	ppbv	0.30	ND
1,1,2-Trichloroethane	ppbv	0.15	ND
1,1,2,2-Tetrachloroethane	ppbv	0.20	ND
cis-1,3-Dichloropropene	ppbv	0.18	ND
trans-1,3-Dichloropropene	ppbv	0.17	ND
1,2-Dichloropropane	ppbv	0.40	ND
Bromomethane	ppbv	0.18	ND
Bromoform	ppbv	0.20	ND
Bromodichloromethane	ppbv	0.20	ND
Dibromochloromethane	ppbv	0.20	ND
Trichloroethylene (TCE)	ppbv	0.30	ND
Tetrachloroethylene (PCE)	ppbv	0.20	ND
Benzene	ppbv	0.18	2.42
Toluene	ppbv	0.20	7.53
Ethylbenzene	ppbv	0.20	0.94
p+m-xylene	ppbv	0.37	4.38
o-xylene	ppbv	0.20	1.5
Styrene	ppbv	0.20	0.21
4-ethyltoluene	ppbv	2.2	ND
1,3,5-Trimethylbenzene	ppbv	0.50	ND
1,2,4-Trimethylbenzene	ppbv	0.50	0.58
Chlorobenzene	ppbv	0.20	ND
Benzyl chloride	ppbv	1.0	ND
1,3-Dichlorobenzene	ppbv	0.40	ND
1,4-Dichlorobenzene	ppbv	0.40	ND
1,2-Dichlorobenzene	ppbv	0.40	ND
1,2,4-Trichlorobenzene	ppbv	2.0	ND
Hexachlorobutadiene	ppbv	3.0	ND
Hexane	ppbv	0.30	1.99
Heptane	ppbv	0.30	1.88
Cyclohexane	ppbv	0.20	0.36
Tetrahydrofuran	ppbv	0.40	4.46
1,4-Dioxane	ppbv	2.0	ND
Xylene (Total)	ppbv	0.60	5.88
Vinyl bromide	ppbv	0.20	ND
Propene	ppbv	0.30	ND
2,2,4-Trimethylpentane	ppbv	0.20	0.41
Carbon disulfide	ppbv	0.50	8.70
Vinyl acetate	ppbv	0.20	ND

Notes:
1) Results are from sampling performed on Saturday, August 17, 2013.
2) ND - Not Detected, less than the limit of method detection.
3) - - No value established in the detection limit and reference criteria.
4) For further information, the reader should refer to the laboratory report in Appendix A.

Table 5D
Analytics Results - Soil Vapour - Siloxanes

Parameter	Detection Limit		VW-01	
			08/17/2013	
	mg/m³	ppm	mg/m³	ppm
Trimethylsilyl Fluoride	- -	- -	0.0007	0.0002
Tetramethylsilane	0.0001	0.0001	ND	ND
Methoxytrimethylsilane	0.0018	0.0004	ND	ND
Ethoxytrimethylsilane	0.0017	0.0004	ND	ND
Trimethylsilanol	- -	- -	0.0394	0.0107
Isopropoxytrimethylsilane	0.0007	0.0001	ND	ND
Trimethoxymethyl Silane #	- -	- -	ND	ND
Hexamethyl Disiloxane - L2	- -	- -	0.0005	0.0001
Propoxytrimethylsilane	0.002	0.0004	ND	ND
1-Methylbutoxytrimethylsilane *	- -	- -	ND	ND
Butoxytrimethylsilane *	- -	- -	ND	ND
Trimethoxyvinyl Silane #	- -	- -	ND	ND
Hexamethyl Cyclotrisiloxane - D3	- -	- -	0.0074	0.0008
Octamethyl Trisiloxane - L3	0.0001	0.0001	ND	ND
Triethoxyvinyl Silane #	- -	- -	ND	ND
Triethoxyethyl Silane #	- -	- -	ND	ND
Octamethyl Cyclotetrasiloxane - D4	- -	- -	0.0071	0.0006
Decamethyl Tetrasiloxane - L4	0.0002	0.0001	ND	ND
Tetraethylsilicate #	- -	- -	ND	ND
Decamethyl Cyclopentasiloxane - D5	- -	- -	0.0160	0.0011
Dodecamethyl Pentasiloxane - L5	0.0017	0.0006	ND	ND
Dodecamethyl Cyclohexasiloxane - D6	- -	- -	0.1747	0.0096
Sum	- -	- -	0.2541	0.0245

Notes:

1) Soil vapour samples collected on Saturday, August 17, 2013.
2) ND - Not Detected, less than the limit of method detection.
3) - - No value established in the detection limit and reference criteria.
4) V=200 mL, where V is volume of air/gas sampled.
5) * - Semiquanititative (response factor set at 5).
6) # - Unstable, poor detectability, commercial standards tested.
7) For further information, the reader should refer to the laboratory report in Appendix A.

APPENDIX F

BOREHOLE LOGS

PROJECT: Phase II ESA Historic Waste Disposal Sites	**BOREHOLE No.:** VW-01
PROJECT No.: 12-435	**DRILL TYPE:** SS Auger
LOCATION: McKenzie Trails Recreation Area	**GROUND ELEVATION:** 853.853 m
CLIENT: The City of Red Deer	**COMPLETION DATE:** 06/20/2013

Sample Type: Shelby Tube | Split Spoon | Core | Disturbed | No Recovery

Backfill Type: Bentonite | Silica Sand | Grout | Pea Gravel | Drill Cuttings | Bentonite : Sand

Notes: Soil Vapour Well on east side of the park road (near the northeast quadrant of the pond)

Depth (m)	Soil Description	Sample Type	Sample No.	SPT (N)	Combustible Soil Vapours (ppm)	Well Details
0.0	Sod and loam (fill) - loose, silty, sandy, trace rootlets, moist, dark olive. (~ 15 m thick).					
	Sand and gravel (fill) - compact, silty, trace rootlets, trace organics, moist, dark olive.					
1.0	becomes wet at 2 m.					
2.0	End of hole at 2.0 m. 25 mm diameter 0.3 m length 020 PVC screen. Aboveground lockable steel casing set in concrete.					
3.0						
4.0						
5.0						
6.0						
7.0						
8.0						
9.0						
10.0						
11.0						
12.0						

Tiamat Environmental Consultants Ltd.

Slough : None	Completion Depth (m): 2
Depth to Groundwater :	Checked By: LTM
Logged By: LTM	Page: 1 of 1

PROJECT: Phase II ESA Historic Waste Disposal Sites	**BOREHOLE No.:** MW-01
PROJECT No.: 12-435	**DRILL TYPE:** SS Auger/ODEX
LOCATION: McKenzie Trails Recreation Area	**GROUND ELEVATION:** 848.292 m
CLIENT: The City of Red Deer	**COMPLETION DATE:** 06/20/2013

Sample Type: Shelby Tube | Split Spoon | Core | Disturbed | No Recovery

Backfill Type: Bentonite | Silica Sand | Grout | Pea Gravel | Drill Cuttings | Bentonite : Sand

Notes: Groundwater Monitoring Well near VW-01

Depth (m)	Soil Description	Sample Type	Sample No.	SPT (N)	Combustible Soil Vapours (ppm)	Well Details
0.0	Sod and loam (fill) - loose, silty, sandy, moist, dark olive. (~ 15 cm thick).					
	Sand and gravel (fill) - loose, silty, trace organics, moist, dark olive.					
1.0						
2.0	becomes wet at 2 m.					
3.0						
	Sand and gravel (native) - compact, trace silt, wet, olive.					
4.0						
5.0						
	End of hole at 5.5 m. 51 mm diameter 4.6 m length 010 PVC screen. Aboveground lockable steel casing set in concrete.					
6.0						
7.0						
8.0						
9.0						
10.0						
11.0						
12.0						

Tiamat Environmental Consultants Ltd.

Slough : None	Completion Depth (m): 5.5
Depth to Groundwater :	Checked By: LTM
Logged By: JAL/LTM	Page: 1 of 1

PROJECT: Phase II ESA Historic Waste Disposal Sites	**BOREHOLE No.:** TH-03
PROJECT No.: 12-435	**DRILL TYPE:** SS Auger
LOCATION: McKenzie Trails Recreation Area	**GROUND ELEVATION:** 850.002 m
CLIENT: The City of Red Deer	**COMPLETION DATE:** 06/20/2013

Sample Type: Shelby Tube | Split Spoon | Core | Disturbed | No Recovery

Backfill Type: Bentonite | Silica Sand | Grout | Pea Gravel | Drill Cuttings | Bentonite : Sand

Notes: Testhole in north central area of waste; south of north parking lot and east of park maintenance storage

Depth (m)	Soil Description	Sample Type	Sample No.	SPT (N)	Combustible Soil Vapours (ppm)		Well Details
0.0	Sod and loam (fill) - loose, sand, silty, trace rootlets, damp, olive. (~ 10 cm thick)						
	Silt (fill) mixed with MSW - some organics, masonry brick fragments, ash, some plastic, grass clippings, news print, magazines, wood fragments, wire, glass, tin can, soft, loamy, trace rootlets, trace clay, damp, olive brown.						
1.0							
2.0							
3.0	becomes wet at 3 m.						
4.0							
5.0							
	Silt (native) - firm, trace sand, moist, olive brown.						
6.0	No obvious waste material.						
	Shale (bedrock) - weak, highly weathered, damp, grey.						
7.0							
	End of hole at 7.6 m.						
	Backfilled with bentonite chips to 5.5 m; ~ 50:50 bentonite and silica sand to surface.						
8.0							
9.0							
10.0							
11.0							
12.0							

Tiamat Environmental Consultants Ltd.

Slough : None	Completion Depth (m): 7.6
Depth to Groundwater :	Checked By: LTM
Logged By: LTM	Page: 1 of 1

PROJECT: Phase II ESA Historic Waste Disposal Sites	**BOREHOLE No.:** TH-04
PROJECT No.: 12-435	**DRILL TYPE:** SS Auger
LOCATION: McKenzie Trails Recreation Area	**GROUND ELEVATION:** 850.580 m
CLIENT: The City of Red Deer	**COMPLETION DATE:** 07/11/2013

Sample Type: Shelby Tube | Split Spoon | Core | Disturbed | No Recovery

Backfill Type: Bentonite | Silica Sand | Grout | Pea Gravel | Drill Cuttings | Bentonite : Sand

Notes: TH-04 near the parking lot for the picnic area

Depth (m)	Soil Description	Sample Type	Sample No.	SPT (N)	Combustible Soil Vapours (ppm)		Well Details	
0.0	Sod and loam (fill) - sandy, trace silt, damp, olive. (~ 8 cm thick) Sand (fill) mixed with MSW - organics, minor plastic pieces, metal, trace glass fragments, strong pungent odour, compact, silty, moist, olive brown.							
1.0								
2.0	Silt (fill) - firm, sandy, moist, olive. charred wood fragments with sand and gravel matrix at 2.4 m.							
3.0	No obvious waste material. Sand and gravel (native) - compact, wet, olive. becomes wet at 3.8 m.							
4.0								
5.0								
6.0	Siltstone (bedroock) - weak, highly weathered, moist, grey.							
7.0	End of hole at 7.6 m. Backfilled with ~ 50:50 bentonite and silica sand.							
8.0								
9.0								
10.0								
11.0								
12.0								

Tiamat Environmental Consultants Ltd.

Slough : None	Completion Depth (m): 7.6
Depth to Groundwater :	Checked By: LTM
Logged By: LTM	Page: 1 of 1